BOYLE

—

MEDICINA HYDROSTATICA

1690

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VERUM ATQUE DECENS
William Lee ESQ.
of Hartwell
BUCKS:

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EXPERIMENTS AND OBSERVATIONS, Relating to the Materia Medica.

TOME I.

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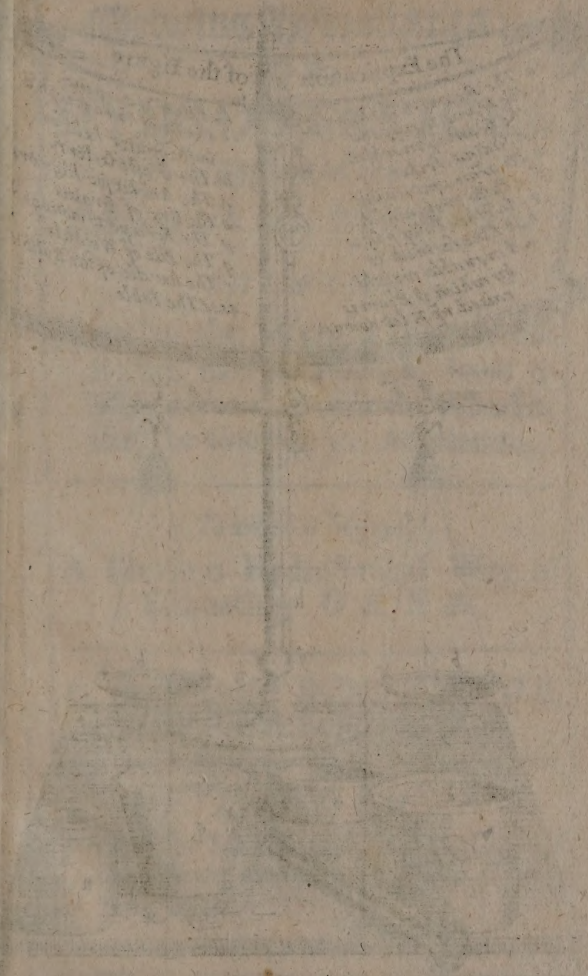

The Explication of the Figure
a a The Beam. b b The Dishes.
c c The Frame to suspend the Beam upon which
d a Sliding Socket
e Its arme containing
f a Pully over which
g An other Pully passes
h A Line fastned to
i A movable weight by which the Beam is raised up, & let downe.
k A Hair to suspend
l The Body to be weigh'd in the water held in
m The Glasse Cestern
n The Buckit for Liquors
o The Box of Grains
p The Forceps to manage
q The Pile of Weights
r The handle of the Ballance
ssss The Table.

Medicina Hydrostatica:
OR,
HYDROSTATICKS
Applyed to the
MATERIA MEDICA.

SHEWING,

How by the Weight that divers Bodies, us'd in Physick, have in Water; one may discover Whether they be Genuine or Adulterate.

To which is subjoyn'd,

A Previous Hydrostatical Way of Estimating *ORES.*

By the Honourable ROBERT BOYLE, *Fellow of the* Royal Society.

LONDON,
Printed for *Samuel Smith* at the Sign of the *Princes Arms*, in St. *Paul's Church-Yard*, 1690.

28835

HYDROSTATICKS:

OR,

A TREATISE

OF

MAGNITUDE, WEIGHT,

AND

EQUILIBRIUM

OF

FLUIDS:

Shewing by what Weights that diverse Bodies, and in Particular, how much Water, one contains more than another.

Useful for Examining the Adulterate.

By the Honourable ROBERT BOYLE, Fellow of the Royal Society.

LONDON,

Printed for Samuel Smith, at the Sign of the Prince, in St. Paul's Church-yard, 1690.

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THE PREFACE.

I Am far from being fond of their Practice, that affect to give pompous and promising Titles to their Books; in so much that my Friends have several times reproached me with inclining too much to the opposite Extream. But yet I am not averse from prefixing to the ensuing Paper, the Title of *Medicina Hydrostatica*; not only for the Conveniency of Citations, (which are usually troublesome to make in Tracts that have long Titles;) but because too I am Invited, if not Authorized to do it, by the Example of the famous and judicious *Sanctorius*; who scrupled not to prefix the Name of *Medicina Statica*,

to a Writing almoſt as Small, as 'tis Ingenious, which applys the Ballance to *Some* Uſes relating to the Medicinal Art, perhaps *not More*, than will be here found propoſed of the ſame Inſtrument, improv'd by ſome Additions. And 'tis ſcarce to be doubted, but that in this Inquiſitive Age, the Sagacity of the Curious will make, both of what he has diſcovered, and of what I have delivered, uſeful Applications, that neither He, nor I, ever thought of.

If the chief thing, I aimed at in Writing, had been to gain Applauſe, I would have taken a more likely way to obtain it, than by treating of a Subject, wherein few will think themſelves concerned, (tho' many in reallity be ſo, and whoſe Importance does not at firſt view appear.) And this Subject too, the Nature of it has obliged me, to treat of in ſuch a way, that it will be almoſt as unpleaſant to the Reader to peruſe ſo unadorned a piece, as it was troubleſome to the Author to write ſo

Toileſome

Toileſome an One. And indeed when I came to take notice of the Number of Particulars, that I had brought together into this little Book; I did my ſelf ſomewhat wonder, how I came to be prevailed with to lay out ſo much Pains upon ſo uninviting a Subject. But Knowledge and Health are two ſuch valuable things, that I durſt not refuſe to undergo, even a toileſome Task; whilſt I was encouraged by the Hope, that was given me, that this kind of Labour may conduce ſomewhat to thoſe deſirable Ends; if not otherways, yet at leaſt by exciting the more curious among Phyſicians, Chymiſts, and Others, to inlarge their Inquiries, and by helping them to remark divers things relating to Medicinal Bodies, that they are wont to overlook.

I had probably better conſulted my Reputation, as well as my Eaſe, if, having contented my ſelf with thoſe few uncommon Notions, and Obſervations, that the reſt of the

Book

Book was built upon; I had left the Applications made of them to particular Bodies, to the industry of Others. I shall not solicitously excuse my self, for not having bestowed more Ornaments upon the following Essay; since the Nature of the Subject and Drift of the Writer, are sufficient to justifie the Plainness of my Style to the Judicious. I may have somewhat more cause to Apologize for this; That I have not cast a Treatise about a Subject wherein Mechanicks are so much imployed, into the Form of Propositions; and given it a more Mathematical Dress. But I was unwilling by that means to discourage those many, who, when they meet with a Book, or Writing, wherein the Titles of *Theoreme*, *Probleme*, and other Terms of Art, are conspicuously placed, use to be frighted at them; and thinking them to be written only for Mathematical Readers, despair of understanding it; and therefore lay it aside, as not meant for the use of such, as they.

But

But there is another thing, upon whose score, I confess, I ought to wish for indulgent Readers. For the Papers compiled into this Essay, having been written in loose Sheets, and at such distant times, that divers Accidents interven'd between them; the loss of some of those Papers, as well as others of different Natures, and my want of Health, and Leisure, obliged me to change more than Once my proposed design, and to imploy sometimes the Style of a private Letter, and sometimes again, that of a Discourse intended for the Publick; By which, means some Things, and some Expressions, that were suitable to the Design I had, when I committed them to Paper, became incongruous, when the Scope and Scheme of my Discourse were altered, especially Some parts of the Copy being out of my hands, when I should have adjusted the Others to them. But tho' these Irregularities may keep the parts of this Essay,

from

from being so coherent as they should be; yet they will not prove very prejudicial to an intelligent Reader; who, finding the Matters of Fact, and the Notions, to be true, may, notwithstanding the want of an uniform Contexture, make good use of them.

Tho' divers little *Memoirs* and other things, that occurred to me from time to time, whilst I was bringing together the following Papers, have insensibly swelled them into a Book; yet the Essay it self was in my First intention, but a large Fragment of a greater work: whereof an Account is given in the Letter to a Friend, (that is premis'd to a Paper annexed to the following Essay,) which (Letter) having been intended for a kind of Preface to the last Scheme of the whole larger work; if the Reader please to peruse it, he will there find the Rise, and Scope of this little Tract, as well as of the other parts of that designed Book; and some other things, that

that may make it needleſs to lengthen this Preamble by any thing more than two Advertiſements. Of theſe, *One* is, that, being reduced by divers unexpected, and unwelcome Accidents to forego my firſt deſign, and give only two or three *Specimens* of what was intended, and more than begun; I made choice of the Title of the Chymical Changes of Bodies by Coloration, as a Sample of the Chymical part of the Treatiſe; and I pitcht upon the Subject of this preſent Eſſay, as a *Specimen* of the Mechanical part of the ſame Treatiſe; The *other* Advertiſement, is, that the Reader need not be ſtartled, to find ſome little Variations of Specifick Gravity, among ſome of the *Memoirs* laid together in this *Eſſay*, becauſe he will in due place be told, why ſuch things ought to be expected. And in the mean time, it may, I hope, ſuffice to ſay, that ſuch Variations are neither new, nor eaſily avoidable things, in making *Hydroſtatical* Experiments or others of Affinity to them. For

See the Chapters.

Proof

Proof of which, to Readers, that, for want of having made Tryals themselves, may distrust what we have said, I shall produce a Couple of notable Testimonies. The first is given by so industrious and diligent a Mathematician, as *Mersennus* himself. For he candidly acknowledges, when he has occasion to mention some Tryals of the learned *Ghetaldus*, and of the accurate French Engineer *Monsieur Petit*, & of his own; that the Variety of weighing, which often happens to amount to some Grains, is but like the Variety of Astronomical Observations; which do almost always differ in some Minutes or some Seconds. To which he soon after adds an Intimation, that shews, that he expected not an exact uniformity between the Observations of *Ghetaldus*, &c. already made, and the Tryals of an Experimenter, that would examine them by making the like again.

Varietas ponderandi, quæ setius in quibusdam Granis contingit, similis est Varietati Astronomicarum Observationum quæ semper feré quibusdem minutis, sive Primis, sive Secundis differunt. Mersennus in Phœnomenis Hydraulicis.

To this first Testimony we shall subjoyn the Second, which is, that our famous

famous Experimenter, the Lord *Verulam* himself, writing of a Subject, that in several things has much Affinity with ours, confesses, that 'tis not to be doubted, but that many of the Bodies, which he has set down in his Table of their Dimensions, and Weights differ in the same *Species* or Denomination; some being heavier than others, and that therefore there is some Contingency in this Affair, so that 'tis not necessary, that the Individuals he made his Tryals with should be exact Standards of the Nature of their respective *Species*, or should, (which makes directly to my present purpose) agree altogether to a Title with Experiments of other Men.

Hist. densit. & Rarit. P. M. 12. *Editionis Londinen. in Octavo.*

But this scarce evitable Imperfection of *Hydrostatical* and the like Experiments does not hinder, but that by their help we may make good Estimates of the Weights, and Bulks, of very many Bodies; and among them of not a few that belong to two sorts of the three, that our Illustrious

lustrious Author acknowledges to be reducible to his Way of Mensuration. And these Estimates will (if I mistake not) be found, not only preferable to those that can be made of the same Bodies by Geometrical Instruments; but (which is more considerable for the Reader) accurate enough to be very useful on a great Number and Variety of Occasions. Which last Clause, I purposely add to insinuate, that the Hydrostatical Way of Mensuration may be usefully apply'd to several Bodies and Cases, that do not at all seem to relate to the *Materia Medica*, as would appear by inserting here what is delivered *about Metrical*, and *about Exploratory Experiments and Observations*, in other Papers; if that were not too foreign to the ensuing Essay, as not belonging to the Subject, or to the Design of it.

Medicina

Medicina Hydrostatica.

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ERRATA.

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Medicina Hydrostatica:

AN

ESSAY:

CHAP. I.

I have, in a former Tract, endeavour'd (and, as I am told in Print, and otherwise, not altogether unsuccessfully) to make it probable, that divers, if not most, of the real Virtues (for many fabulous Ones have been ascrib'd to them) of Gems or precious Stones, may in great part proceed from the Qualities of Metalline and Mineral Substances, That, whilst the Matter was either fluid or soft, were (more or less plentifully) incorporated with the stony Mat-

ter, which hardned afterwards into a Gem. The same *Phænomena* and Reflections, that led me to the Opinion newly recited, induced me to think it also very probable, that divers Boles, Clayes, and other Earths, and, much more, that several Minerals; which, tho' not looked upon as Metalline Oars, and several Stones or stony Substances, that, by reason of their Bigness or Opacity, or perhaps unpleasant Colours, have been judged unworthy to be numbred among Gems or precious Stones, may yet be indowed with considerable Medical Virtues; & perhaps with greater than the finer Gems themselves, because in these despised Stones and Minerals, there is often found a greater store of Metallick and Mineral parts, which, while they were in *solutis Principiis*, as Chymists speak, might with ease plentifully insinuate themselves into these more open Bodies, where being setled they were not lockt up so fast and strongly, as in the nobler Gems; such as Diamonds, Rubies,

Saphirs,

Saphirs, *&c.* which are of so Compact, and as 'twere Glass-like, a Nature, that divers Corrosive Liquors, and *Aqua Fortis* it self, are unable to penetrate and dissolve them; tho', as hereafter will appear, these inferiour Medical Stones, and other Minerals, may be opened by the like *Menstruums*.

Upon these Grounds, I thought it might be a thing of use to Physicians, as well as to divers Mineralists and Mine-workers; if I imparted to them a Way of Exploring many Fossils, that I do not remember I had met with, either among Physicians or Chymists: And tho' this Way of Exploration pretends not to discover directly more than one Quality of the Body examined by it; yet that Quality, being its specifick Gravity, is so radical and considerable a one, that it may lead a Sagacious Enquirer further than at first sight one would think.

I considered then, that the most pure and homogeneous kind of Stones

we know of, and that seems the freest from all adventitious Mixtures, and even * TR's. is Rock-Chrystal: And therefore I pitched upon This, as the Standard I would imploy, to make Estimates of the greater or lesser recess from Simplicity or Homogeneity of the Stones, or other Stone-like Substances, whose specifick Gravity I should examine.

*Tinctures

We took then some Pieces of native Chrystal, clear and colourless, and having carefully weighed them first in the Air, and then in Water, we found, by Computation, that pure Chrystal was to clear Water of the same Bulk, as Two and an half, or thereabouts, are to One: So that, to clear the Matter by an Instance, if we suppose an hollow Cube, of Brass or other Metal, to be filled as carefully as may be, (for the upper Surface will scarce be exactly Level) with ℥j. of Water, and if afterwards the Cavity of the empty'd Vessel be exactly filled with a Cubical piece of Rock Chrystal; this Stone will weigh

weigh ℥ij and about an half. Some of my Tryals indeed, made with tender Ballances, repreſented the Proportion of theſe two Bodies, with ſome petty Variation. But beſides, that 'tis not improbable, that differing pieces of Rock Chryſtal it ſelf, tho' of equal Bulk, may not be preciſely equal in Ponderoſity; beſides this, I ſay, the Variation I found from the newly aſſigned Proportion was ſo ſmall, that having juſt intimated, that for the moſt part it rather favoured a little the ſpecifick Gravity of the Chryſtal, than fell ſhort of it; we may neglect it without any prejudice, worth taking notice of, to the Uſe that is to be made of this Proportion in this Paper. And for as much as there may be ſome Scruple, tho' groundleſs, made about the Origin and Nature of Chryſtal: I ſhall add, by way of Confirmation of what has been delivered, that I procured ſome ſtrong Icicles, that had been faſten'd to Vaults, &c. as Bodies that would be acknowledged to

be true Stones, and yet to have been in a Liquid Form; and having Hydroſtatically examined theſe Concretions, the ſpecifick Gravity, tho' not exactly the ſame in all, appeared to be little differing from that of Chryſtal; the ſolid Body exceeding the Weight of the fluid water, it Was Weigh'd in, about two times and an half, (a little more or leſs.)

Uſe I. To apply this Fundamental Obſervation to the Uſes deſigned in it, when I had a mind to make a probable Diſcovery, (for by this Way I pretend to no more) whether in a Stone, or Stone-like Body propounded, the merely ſtony Matter were more or leſs commixt with ſome adventitious Subſtance of a Metalline Nature, or that of ſome other Mineral more ponderous than Chryſtal, I carefully weighed it: Firſt in the Air, and then in the Water, according to the Method formerly declared, and if by Virtue of its ſpecifick Gravity, its Proportion to Water of the ſame Bulk, exceeded the Proportion of five to

to two (which to avoid Fractions, may be commodiously substituted to that often already mentioned of 2 ½ to one) I concluded it probable, that the Concretion had in it a Portion of adventitious Matter, heavier *in Specie* than Chrystal or mere Stone, by how much more or less the solid Body exceeded the Weight of Water equal to it in Bulk, by so much greater or lesser a Portion of Heterogeneous Matter was guest to be commixed with the stony in the propounded Concrete. This may be illustrated, as well as proved, by the Examples that should presently follow, but that it will be fit, before I descend to Particulars, to premise a Paper that concerns the whole Design of this Tract.

CHAP. II.

THO' the Way of weighing Solids in Water hath been deli-

vered by the ingenious *Marinus Ghetaldus*, and, out of him, by ſome few other Authors; and tho' therefore I might excuſably diſpenſe my ſelf from delivering it diſtinctly: *Yet* ſince their Books are ſcarce, and the knowledge of this Way is almoſt every where ſuppoſed in theſe Papers, I hold it very fit, that it ſhould once be propoſed in this Tract, not only for that Reaſon, but for Two others. *One*, that a dextrous way of finding out the Weight of Bodies in Liquors, may be of far more uſe than Men ſeem to be yet aware of, being capable of being made, by a little Variation and Improvement, of good uſe to Naturaliſts, and even to Chymiſts. And the *Other*, that perhaps you will find cauſe to think, that Experience and Reflections on it may have furniſht me with ſome few Expedients and Cautions for the better Practice of this Art, and for the avoiding of ſome Errors, that may be very eaſily, and perhaps have been, run into, for want of the Cautions here given.

The

The Way of weighing sinking Bodies in Water.

The Solid Body, given to be examined, is to be ty'd about with an Horse-hair of a competent length, which Hair at its other end is to be fastened to one of the Scales of a tender and exactly equilibrated Ballance, so that, the proposed Body, being exactly weighed in the Air, and then immersed in a Glass or other fit Vessel, almost full of fair Water, may hang freely in that Liquor, being on every side encompassed by it. This done, you must put into the opposite Scale as many Weights, as serve to bring the Body hanging in the Water, to an exact *Æquilibrium* with the Counterpoize, and consequently the Beam of the Ballance to an Horizontal Scituation. Then take out the Weights newly imployed, which give you the Weight of the Body in the Water, and deducting it from the Weight formerly taken of

the

the ſame Body in the Air, and by the remainder, which will be the difference of theſe two, divide the whole Weight of the given Body in the Air, and the Quotient (whether conſiſting of whole Numbers, or a Fraction, or both) will ſhew the Proportion, in ſpecifick Gravity, between the examined Solid, and as much Water as is juſt equal to it in Bulk. To make this more eaſily intelligible by an Example; We took a fine piece of white Marble, (that Stone ſeeming the moſt pure, and moſt free from Mineral Tinctures of any common opacous Stones) this being put into a good Ballance, whoſe Scales were well equilibrated, was found to weigh in the Air, ℥ij ʒiij ℈ı. Grains 1x. which, for Conveniency of Supputation, we reduce to 1169 Grains, then an Horſe-hair was ty'd about this piece of Marble, and the other end of the ſame Hair was faſtened to one of the Scales, under which, at a convenient diſtance, was plac'd a ſomewhat deep Glaſs, almoſt full

full of fair Water, in this Liquor the Stone was made to hang freely, beneath the Surface, and in the opposite Scale, there were put Weights enough to bring it to an *Æquilibrium* with the other, these Weights were found, being reduced to the former Denomination, to amount to 738. Grains, which gave us the Weight of the Marble in Water, (which was much less Weight than the former, because the Stone was partly sustained by the Water) this being substracted from the Weight of the same Stone in the Air, there remained 431. Grains, which gave us the Weight of as much as was equal to the Stone in Bulk. By this remainder the Weight of the Marble in the Air, *viz.* 1169 being divided, the Quotient was found to be 2 & $\frac{71}{100}$, or near enough $\frac{7}{10}$ for the Proportion in specifick Gravity of White Marble to water. The Demonstration of this Practice is founded on what I have elsewhere given, and it may, in another way, be found in some of the Commentators on *Archi-*

Hydrostatical Paradoxes.

Archimedes, *de Insidentibus humido*.

For understanding of the Summary Direction newly given, it may be useful to subjoyn the following Notes: First, 'tis manifest by the Nature of the thing, that the Body, proposed to be weighed, ought to be heavy enough to sink in Water, since otherwise its Weight in that Liquor being none at all, cannot be significantly deducted from its Weight in the Air; but if there be occasion to Weigh in Water a Body lighter *in Specie* than it, as Bees-wax, a piece of Firr-wood, *&c.* It may be done, tho' not without some trouble, by joyning to it a Body, heavy enough to make the Wax sink with it, but this Case belongs not to this place.

2. An Horse-hair is made choice of, for Hydrostatical Operations; because its said to be Equiponderant to so much Water; and tho' I have not found that to be strictly true, yet an Horse-hair is fitter to be imployed in these Tryals, than any other string, I know of; and its specifick Weight

usually

usually differs so little from That of Water, that the Difference may be safely enough neglected; and if the Solid proposed be too heavy to be sustained by a single Horse-hair, one may twist two, (or, if need be) more of them, to make the string strong enough to sustain the Solid.

3. I shall add, that I have met with Bodies, about which, by Reason of their Roundness, as in Bullets, or of some other inconvenient Figure, we could not well fasten an Hair, or other string, wherewith to tye it to the Ballance. Now, on such occasions, I caused some Hairs to be so contex'd, as to make a kind of a little Hoop-net, whose Meashes were not great enough to let the Body slip through them. In this small Vessel, whether you call it a Net or a Basket, which was ty'd by an Horse-hair (single or twisted) to one of the Scales, we put the solid Body to be weighed, and proceeded in the Operation, as if the Body were tyed but with a string.

4. But

4. But here it muſt be carefully noted once for all, that whenſoever any Hydroſtatical Tryal is made with an Horſe-hair; there muſt be put into the Scale that holds the Counterpoize, as much of the ſame Hair, as can be gueſt to be of the ſame Weight with that part of the ſtring that ſuſtains the Body in the Water, which appears to be above the Surface of the Water; for this Liquor takes off the Weight only of as much of the Hair as is immers'd in it, ſo that the unimmers'd part of the ſtring adds to the Weight of the Solid hanging in Water; and therefore, ought to be compenſated by an equal Weight put into the oppoſite Scale.

5. When I kept a Ballance, only or chiefly, for Hydroſtatical Tryals; I found it expedient, on divers occaſions, to take off one of the Scales with the ſtrings belonging to it, and ſubſtitute in its room a piece of Lead, or other Metal of a Conical, or ſom other convenient, ſhape, exactly Equiponderant to the oppoſite Scale,

and

and at the same end of the string, to fasten one end of the Horse-hair that tyed the Body to be weighed in Water. And sometimes also, when I did not take off one of the Scales, I caused it to be perforated in the middle, (yet, without lessening its Weight) that so the Body, to be immerst, might hang very Perpendicularly from the midst of the Scale. The Motives, that induced me to these Practices, cannot be so well set down in few words; and therefore shall be now left unmentioned, especially because the Practices themselves, tho' on some occasions convenient, are not necessary.

6. There remain yet a couple of Remarks, which must less than any be pretermitted, if Men would avoid some Errors, that are but too often slipt into, by the Makers of Hydrostatical Tryals. We are then (First,) to take notice, that the Body, to be examined, hang freely in the Water, so that no part of it any where touch the bottom or the sides of the Vessel,

or

or reach above the upper Surface of the Water contained in it; for, if any of these Circumstances be not taken care of, (as it happens, when we are not heedful enough) the true Weight of the Solid is somewhat altered; and if any Corner, or other part of the Body, (and the like may be said of the Horse-hair, 'tis tyed with) tho' but a small one, appear above the Surface of the Water: That extant Portion, being not at all sustained by the Liquor, adds (more or less) to the Weight, that the immerst Body should have. Care also must be had, that, as nothing but the Water do touch the hanging Body, so, no part of the Water may touch the Scale whence it hangs. I have several times observed, that immerst Bodies have been concluded to weigh more in the Water than really they did; because, through such a want of Heedfulness, as is not uncommon, the Experimenters did not take notice, that if the string were too short, or the Vessel too full; the vibrating Motions

ons of the Ballance, would, at one time or other, carry down the Scale, the ſuſpended Body was ty'd to, ſo low, as to make one part or other of it touch the Surface of the Water: ſome Drops of which Liquor would readily ſtick to it, and, becauſe they adher'd to the nether part of it, would lye concealed from an Eye that was not prying, and by conſequence would ſenſibly add to the Weight of the Scale, and make the Body be thought heavier than indeed it was; which Over-ſight muſt needs be very prejudicial, when one makes Experiments that require Exactneſs.

7. But the moſt uſual Cauſe of Miſtakes in Hydroſtatical Tryals, (eſpecially ſuch, as are made on ſmall Bodies) wherein a little Error may be greatly conſiderable, is this; that Men are wont to think it ſufficient, (in theſe Tryals) that the Body to be examined, be totally immerſt in the Water; whereas it does not only often, but moſt commonly happen,

that the given Solid, and the ſtring that is tyed about it, carry down with them divers Particles of Air; and perhaps too, it may find and extricate others, that lay concealed in the Pores of the Liquor it ſelf; which *Aerial* Particles faſten themſelves to the little Aſperities, that they meet with on the Surface of the immerſt Bodies, in the form of Bubbles, which, like ſo many little Bladders full of Air, endeavour to buoy up the Body they adhere to; and on that account do, in Proportion to their Number and Bigneſs, leſſen the Weight, which the immerſt Body would otherwiſe have in Water. And therefore, great care is to be had, eſpecially in nice Experiments; that, by ſhaking the ſtring, and warily knocking the Body againſt the ſides of the Glaſs, the adhering Bubbles may be diſplaced, and emerge to the top of the Water: And I ſhall add a deſire, that on ſome occaſions this Caution be made uſe of more than once in the ſame Tryals; becauſe I have ſeveral

times

times observed, that now & then after the immerst Body was freed from the first Bubbles that appear'd about it, others did succeed, before an end was made of weighing the Body; out of some of whose unperceived Cavities, or Pores, (whether superficial or lying deeper) perhaps the latent Air could not easily on a sudden be driven by the Water. I have been the more Circumstantial in explaining the summarily proposed Method of Weighing Bodies in Water, because Experience hath shewn, that 'tis not near so easie, as, upon the first reading of it, one would presume; to be exact in the Practice of it.

Having obtained the Weight of a Body proposed; First, in the Air, and then in Water, according to the Method plainly delivered; 'twill not be difficult to discover *Practically* the Proportion in Weight, between the Solid and the Liquor. I say *Practically*, because the Rule is easie enough, tho' the Demonstration is not so readily to be understood by them, that

are not acquainted with the Principles of the Hydrostaticks. The *Theorem*, upon which our Practice is grounded, was first, that we know of, delivered by the most sagacious *Archimedes*; whose Commentators have busied themselves in demonstrating it in a Mathematical way, as I have since endeavoured to do in a Physical way, and more easie to Naturalists in the Hydrostatical Paradoxes. *Archimedes*'s Proposition is this, *That a Body, heavier than Water, weighs less in Water than in the Air, by the Weight of as much Water as is equal to it in Bulk or Magnitude*: Whence 'tis not difficult to deduce a Rule sufficing for our present purpose. For if you substract the Weight of the Body proposed, whilst it is every way environed with Water; from the Weight of the same Body, which it was found to have in the Air; the residual Number or Difference gives you the Weight (taken in the Air) of as much Water as is equal in Magnitude to the Solid proposed;

posed; so that, having now two Bodies, one Firm, and the other Liquid, together with the Weight of each of them apart; to find their Proportion, you need but divide the greater by the lesser; and the Quotient compared to One, that is, to an Unite, will be the Antecedent the of the Proportion desired between the solid Body and the Water; which is mentioned, but, as it is the Liquor that is generally imployed in these Experiments, for otherwise the Rule will hold, *mutatis mutandis*, in other Liquors, as well as in Water.

CHAP. III.

AND now having premised these Remarks, and thereby made way for the clearer Understanding of the subsequent part of this Paper; we shall proceed to the Examples, that this not unnecessary Digression has diverted us from propounding.

There is a deeply Red and Opacous Mineral, that commonly passes in the Shops under the Name of *Lapis Hæmatites*, tho' it seems to have more Affinity to that which divers Authors call *Schystos*. But whatever be the most proper Name that belongs to it, it is an hard Fossile, which, tho' little used by our English Physicians, is in several Places abroad in great Request; & that not without cause, as far as I can judge, by what I yet know of it; and especially, for that Somniferous Quality, that may be observed in some of its Preparations. But 'tis not here, tho' 'tis elsewhere, my Purpose to deliver its Medicinal Virtues; but only to examine, whether, according to our Method, it ought to be concluded to abound with Metallick Particles, (perhaps but Embryonated,) to whose Intermixture some of its Virtues may probably be ascrib'd. Therefore, in a very good Ballance, having weigh'd a piece of English *Hæmatites*, that chanced to amount to about ℥iij ʒij ʒ, First, in the Air, and

and then in Water; we found its Proportion to this Liquor, as 4$\frac{11}{12}$ to 1. At which Ponderosity, if I had not formerly made the like Experiments, I should have been surprized; as you probably will be, when you consider, that this Metalline Stone did not very much want of almost twice the Weight of a mere Stone of the same Bulk. This great Weight much confirmed me in the Conjecture I had made; that in this Lump was contain'd a good deal of Metalline Substance. And this induced me (to add that upon the by) to examine my Guess, by subliming it, when finely powdered, and diligently mixt with an equal, or double, Weight of *Salarmoniac*. For then having tasted, with the tip of my Tongue, of this *Saffron*-coloured Sublimate; I found it; as I expected, very Astringent or Styptick, as divers Preparations of *Mars* are wont to be; and, for further Proof, having put less than a Grain of it into a spoonful or two of good Infusion of Galls; there was immediate-

ly produced a Black, and as it 'twere Inky, Mixture.

Lapis Lazuli is sometimes made use of by *European* Physicians, but more frequently by *Arabian* and other *Eastern* Ones, for divers purposes, but especially to make Evacuations by Vomit. This Emetick Faculty seemed, likely enough, to belong to it upon the Score of a Metalline Ingredient; and accordingly, having examined Hydrostatically, a piece that was judged moderately rich, we found the Proportion of it to an equal Bulk of Water, to be as 3. to 1. which argues, That, notwithstanding its briskness in Operation, it contained a much lesser Proportion of Metalline Substance, than *Lapis Hæmatites*, or divers less Operative Minerals.

Observation about the Load-stone, as 'tis a Mineral.

I elsewhere shew, that the Load-stone may be applyed to Medicinal Uses, and that it emits *Effluvia*, that are not Magnetical, and may have sensible Operations upon the Body of Man. On which account, it was not improper

improper to examine it Hydroſtatically; by which means I found, that the Weight of a Lump of Loadſtone, that I judged to be either *Engliſh* or *Norwegian*; was in Proportion to Water of the ſame Magnitude, as $4\frac{93}{100}$ to 1. But of the ſpecifick Gravities of Loadſtones, much more may be met with in another Paper.

Lapis Calaminaris is often enough uſed in Phyſick, eſpecially by Chymiſts, to dry; and to imbibe Acidities. For which Uſes, I prefer it before divers more famous Drugs: But, tho' 'tis wont to be imployed, only as an external Remedy; yet ſome things, that I found in ſome uncommon Chymical Preparations of it, made me think, it may deſerve to be further examined and tryed. A famous and not unlearned Empyrick, to whom I willingly communicated ſome Proceſſes, that he deſired of me; when I asked him about a Medicine, whoſe Succeſs brought him a great number of Patients, for griping Fluxes, and ſome Dyſenterical ones; candidly diſco-

discovered his Medicine to me, and solemnly assured me, it was nothing, but pure and well-ground *Lapis Calaminaris*, seasonably given in a just Dose; as in a fitter place I have more fully declared. This made it obvious for for me to conjecture, that *Lapis Calaminaris* participates of a Metallick Nature, as may be argued from its Operation upon Copper, which is thereby turned into Brass. Wherefore weighing a piece of this Fossile, first in Air, and then in Water, it appeared to be to this Liquor as $4\frac{159}{200}$ to 1.

If I had not among other Papers lost Some, wherein I had Registred a good Number of Tryals of this kind made upon differing Fossiles; 'twould be easie for me to add to the four already recited, others manifestly conducing to the same Purpose. But presuming, that those already delivered may at present suffice; I shall now subjoyn a few Observations, whereof the *first* may become the Candor and Impartiality of a Lover of Truth, and the rest intimate

mate some further Uses of the Hydrostatical Way of exploring hard and ponderous Concretions, hitherto treated of.

I must not therefore forbear to admonish you, that, *tho'* when an hard Fossile propounded, is found to be much heavier than Chrystal of the same Bulk; 'tis a very probable Token, that in the Solid Concretion, there is a notable Portion, greater or lesser, of some Metalline or other ponderous Mineral Body, whence its good or evil Qualities, in reference to human Bodies, may probably be deduced; *Yet*, this hinders not, but that 'tis very possible, for a Fossile to be endowed with Medicinal Virtues, or to have noxious Qualities, on the account of a Portion of extraneous Matter; tho' its specifick Gravity doth but little exceed that of Chrystal; or the advantage seem but inconsiderable. For, (to pass by other Reflections) a very small Proportion of Adventitious, Metalline, or Mineral, Substance, if it be of an

Opera-

Operative Nature, may, in ſome Caſes, ſuffice, to diffuſe its ſelf through the reſt of the Maſs, and impregnate it with active Qualities. Which may be partly Illuſtrated, and partly Proved, by ſome Experiments that will be hereafter met with, in one of the Chapters.

CHAP. IV.

Uſe II. TO hint ſomewhat about the further Utility of our Hydroſtatical Way of Inquiry; I ſhall take notice in the firſt place, that it may aſſiſt us to gueſs, with probability, whether a Mineral Body propounded, as likely to be a Stone, or of a ſtony Nature, be ſo indeed. Thus Coral, for inſtance, is by ſome thought to be a Plant, by others a *Lytho-dendron*, but, by the greater Number, 'tis reckoned among Precious Stones. In this Diſſent of Opinions, the ſpecifick Gravity may be of conſiderable Uſe. Where-

Wherefore, we thought fit to weigh a piece of choice and well coloured red Coral; first, in the Air, and then in the Water, and found its Proportion to the Weight of as much of that Liquor, to be as 2 $\frac{63}{100}$ to 1. So that its specifick Gravity much favours their Opinion, who take it to be a Stone, since it not only equals that of Chrystal, but somewhat exceeds it.

There are Some, that will have Pearls, because of their Hardness, and their being treated of by Jewelers, and others that write of Gems, to be of a stony Nature. Wherefore I thought fit examine their Ponderosity also. But not having now with me any Tryal of that kind; I shall substitute One that I made upon a monstrous Pearl, that was presented me by a Person that took it out of the Oyster. I call it Monstrous, because tho' it be well enough coloured, yet its Shape is irregular, and its Bigness extraordinary; as is also its Weight, amounting to full 206 Grains. This being

being weigh'd in Water, its Proportion in Gravity to an equal Bulk of the Liquor was found to be as $2\frac{51}{100}$ to 1. So that its specifick Weight was much about the same, with that of Chrystal.

There are Many, that take the Stones formed in Mens Bladders, for as true and genuine Stones, as Those that Nature forms in the greater World; and speak much, and sometimes not without ground, of the great Hardness of divers of them. But, tho' I deny not, that, in a laxer Sense, they may well enough pass for Stones; yet I should rather call them *Animal Stones*, than simply *Stones*; this Name having been constantly and generally used, to signifie Mineral or Fossile Stones: which, by our Way of Exploration, may be easily distinguished from human *Calculus*'s, and other like hard Concretions, found in the Bodies of some Animals. For, having examined a good Number of these Stones, I found, that not only the Chymical *Analyses*, I made of them, of which

I elsewhere give an Account, manifested them, how hard soever they were, to be Concretions belonging to the Animal Kingdom, not the Mineral: But, by an Hydrostatical *Examen* of divers of them, I found them to differ much, in specifick Gravity, from true Fossile Stones. Of this you will, in its proper place, meet with several Instances; so that it may here suffice to mention Two, that now chance to come to hand. Namely, that a *Calculus humanus* weighing above ℥vjss was found to be in Proportion to an equal Bulk of Water, as $1\frac{76}{100}$ to 1. And another, that weighed ℥iv and above an half, in the Air, being also weighed in Water, appeared to be to this Liquor, as $1\frac{69}{100}$ to 1.

I mention these Stones as belonging to the *Materia Medica*, tho' they are lookt upon rather as Diseases, of which, indeed, they are very sad Productions, because a famous and experienced Physician, that Practised long in the *East-Indies*, and had better

ter Opportunity than almost any *Europæan* had before him, to try the Virtues of *Bezoar*, does either equal or prefer the *Calculi*, we are speaking of, even to Oriental *Bezoar*.

And to shew, that Men are not the only Animals, wherein Stone-like Concretions differ in specifick Gravity, (and so may be distinguished, by that difference,) from Chrystal and such like true Stones; we shall subjoyn Two or Three Experiments, made upon choice *Bezoar* Stones, not exceeding a middle Size, such being the likelieſt not to be adulterated. The first of these weighing in the Air ʒiij, and odd Grains, was found to be in Proportion to Water of the same Bulk, as 1 $\frac{47}{100}$ to 1. Another weighing somewhat less than ʒiij, was to the Weight of an equal Bulk of Water, as 1 $\frac{13}{100}$ to 1. I might add divers other Instances of the like Import; and tho I think them not necessary, yet I shall subjoyn One more, because 'tis afforded by a *Bezoar* stone, taken out of another of the

the ſame kind: This Kernel-ſtone, if I may ſo call it, being Weighed in the Air wanted Nine Grains of ʒiij, and its Proportion to Water of the ſame Magnitude, was found to be as that of $1\frac{55}{100}$ to 1. In all which Inſtances, we may obſerve, that theſe Animal Stones not amounting to twice the Weight of Water equal to them in Bulk, have leſs of ſpecifick Gravity, by above a Fifth part, than a true Foſſile Stone (ſuch as Chryſtal) is wont to be endowed with.

CHAP. V.

THE Uſe lately propoſed of our Hydroſtatical Way of Exploration, ſuggeſts to me Another, which may be deduced from it, as a kind of *Corollary*. Uſe III.

This comprehends two, ſomewhat differing, Ways of applying the Obſervations, we have lately mentioned. For firſt, we may by the Hydroſta-

ticks be aſſiſted to diſcover, with Probability, the reſemblance, or the difference that may be between Bodies of the ſame Denomination, ſo that ſome ſubordinate *Species* of them, may perhaps be diſtinguiſhed, as well as ſeveral *Individuals* of the ſame, or lowermoſt, *Species*. Since, for Inſtance, we have found a notable difference between the ſpecifick Weights of ſeveral Loadſtones, that were dug up in ſeveral Countries or Mines; if greater Number and Variety of Experiments, of this kind were made, we ſhould poſſibly find, that, *Cæteris paribus*, the Loadſtones of one Country, or of one Mine, are conſiderably heavier than Thoſe of another; as, if I miſtake not, I uſually obſerved, the *Norwegian* and the *Engliſh* Loadſtones to be heavier *in Specie*, than Thoſe that are ſaid to come out of a warmer Region, *Italy*, whoſe Iſland of *Elba* abounds with Mines, whereof I ſaw one intire Maſs that I judged to weigh a great many hundred of Pounds. And this difference

of Weight between Fossiles of the same kind, when 'tis considerable, may be of good use to help us to distinguish between the Stones of the same lowest *Species*, that are proper to differing Countries or Mines. But, in Case the unequal Weight proceeds, as it often does, from an Adventitious Matter, that insinuated it self into the more genuine Matter of the Fossile, whilst 'twas Fluid or Soft, it may much assist us to guess at the greater or lesser Purity of Homogeneousness of the Fossile proposed; which Discovery may, on divers occasions, be of no small use to the Physician, the Jeweller, or the Naturalist.

CHAP. VI.

BUT the Second thing comprized in our *Corlolary*, may in divers Cases be of much greater Utility and Importance, as being very Use IV.

proper to help us to diſcern genuine Stones, whether Animal or Mineral, from counterfeit Ones; which too often paſs for true, to the great prejudice of Phyſicians and Patients, and the great Loſs of *Lapidarie*'s, and their Cuſtomers. For *as* there are few Qualities appertaining to ponderable Bodies here below, that are ſo radicated, (if I may ſo ſpeak) as their Ponderoſity is. So there is ſcarce any Quality, wherein 'tis ſo difficult *for Impoſtors*, to make a notable Alteration unperceivedly, as the ſpecifick Gravity. I ſaid, *for Impoſtors*; becauſe, *tho'* in ſeveral Caſes, 'tis not ſo very difficult, to alter the ſpecifick Weight belonging to this, or that, kind of Bodies; *yet* in thoſe very Caſes, it may be exceeding difficult, and perhaps impractible, to make a conſiderable Change in that Quality, but by ſuch Additions, or Operations, as will make a ſenſible Change in ſome other Qualities too, and thereby expoſe the Fallacy to be diſcovered. And this will eſpecially prove

prove difficult in many Cases to vulgar Cheats, and Counterfeiters, or Adulterators of Gems, and other valuable Minerals; because the little knowledge they have of the Numerousness, and Variety, of Natural and Artificial Productions, confines them to a small Number and Diversity of Means, to accomplish their fradulent Designs. And whilst they are intent, but upon counterfeiting the more obvious Qualities of things; and perhaps of eluding the known and vulgar Tryals Men are wont to acquiesce in; they are not like to take Care to maintain the specifick Gravity, and secure their adulterated Wares, against an Hydrostatical Way of *Examen*, which, probably, they never so much as heard of. By this means, several Perls, for Instance, may be discovered to be Counterfeit, without, in the least, injuring them. And I remember, That some factitious Corals, that, for Divertisement, I made, to shew what might be done in that kind; were, notwith-

standing their fine Colour, Shape, and Glossiness, easily discoverable, by their having a specifick Weight manifestly exceeding That, which belongs to natural Corals.

Before I knew better Ways, I have sometimes, for Recreation, by the help of *Minium* made Pastes, or factitious Gems, which, tho' transparent, and finely enough coloured, yet, because they contained some vitrified Lead, added to the other Ingredients to promote the Fusion, were liable to be detected by an easie Hydrostatical Tryal of their Ponderosity. I have likewise seen a fair *Bezoar* Stone, that so resembled a genuine Stone, That a great Price was set upon it. But being brought me to be judged of, I made little doubt of its being Counterfeit, by reason of its appearing to me as heavy as a Mineral Stone of that Bulk; tho' the Possessor being loth to expose it to an uncommon Tryal, I could not so cogently evince, that I had a clear Reason to disadvise the purchase of it.

CHAP.

CHAP. VII.

AFter these Instances, (which are not the only, that might be alledged of this kind) the affinity of the Subjects invites me to take notice of another Use, or, at least, a Variation of the former, which may be made of our Hydrostatical Way of examining Solids. For it may, on divers occasions, assist us, to make probable Estimates of the Genuineness, or the degree of Purity of several Bodies, that are, or may, usefully be imployed in Physick; tho' they be not Stones or Minerals, provided they be heavy enough to sink in Water. For when we have once found the specifick Gravity of a Concretion of this sort, that we know to be Genuine, and well-conditioned in its kind; this degree of Ponderousness may serve us for a kind of Standard, Use V.

whereby to judge of others, of the ſame Denomination, or that are ſaid to be of a like Nature.

To illuſtrate a Remark, that has no more of Difficulty in it than This, fewer Inſtances will ſuffice, (if any be neceſſary) than you will meet with in the following Part of this Tract, wherein they will opportunely occur. And therefore, inſtead of ſetting them down in this place, I chooſe to give you an Advertiſement, that would ſurprize you, if I had not formerly hinted ſomewhat, appliable to the ſame purpoſe, by no great Variation. For that which I am about to obſerve to you, is, That, I think, there ſhould be made a great difference between the Eſtimate, that Men make of ſome Stones, to which the Shops give the Name of Gems, according as the Eſtimate is to be made by Jewellers and Goldſmiths, or by Phyſicians and Chymiſts. For the Tradeſmen, who uſually aim but at the Beauty and Luſtre of the Gems they would Sell, may juſtly eſteem thoſe

thoſe *Cæteris paribus* the beſt, that are *in Specie* the lighteſt, becauſe ſuch are generally more uniform as to Senſe, and more Tranſparent; and alſo, receive their Colour from Pigments of finer Parts. But, on the contrary, thoſe, that in Gems ſeek mainly, if not only, for the Medicinal Virtues; may juſtly value Thoſe moſt, that are moſt Ponderous: as having more plentiful Portions of the Metallick, or Mineral, Subſtances, whence the greateſt part of their Virtues is, as has been formerly noted, in Probability, to be derived. And this difference in ſpecifick Weight, in Stones that have the ſame Name given them, I ſometimes found to be far greater, than one that has not try'd it would imagine, as may appear by ſome Inſtances, applicable to this Argument, that will hereafter be met with. But yet, I would not hence infer, that even ſuch Stones, whether tranſparent or not, as appear fine, and are but light in their kind, muſt be devoid of Particles,

whether

whether Metalline, or of kin to them, whence they may be endowed with considerable Medicinal Virtues. For there are Mineral Pigments of so subtle a Nature, that so small a Quantity as will scarce make them sensibly heavier than Gems that are less, or perhaps not at all coloured, may be diffused through the whole Matter; and, at least, impregnate every sensible part of it: This I shall Illustrate by the following Experiment, devised for that purpose.

Five Grains of powdered *Zaphora*, being mixed with ℥j ʒ*ſſ* of finely powdered *Venice* Glass, and kept a full hour in Fusion in a Furnace, that gives an exceeding violent Fire, afforded a transparent Mass, that was throughout of a fine blew Colour, and that deep enough; so that one part of the Pigment sufficed to tinge, by Fusion, above an hundred parts of the Glass: And when for Curiosity, we made the Proportion of the *Zaphora* a little greater, taking Eight Grains of the Pigment to ℥j of Glass, that

that is, One to sixty; the Mixture having been kept for the like time in strong Fusion, the Mass was so deeply coloured, that the Proportion of the Tinging stuffe to the rest of the Water, appeared too great to make a handsome Gem.

And further to manifest, that a Quantity of Metalline Matter, tho' it be but very small, may suffice to give a Tincture, and so to impart a Virtue to a Glassy Body, and even to Gems; I shall add an Experiment, that perhaps you will think somewhat strange. I had long conjectur'd, that there was in *Granats*, especially in some that were deeply coloured, pretty store of Metalline *Corpuscles* of a Martial Nature, and that those *Corpuscles* are more than sufficient for the *Granate* it self, into whose Composition they enter, tho' not visibly, because of their extream Minuteness. Upon this supposition, I took a *Bohemian*, or rather *German*, *Granate*, (for I never saw any *Bohemian* so large) that I had kept by me for a Rarity, because of

of its Bigness and deep Colour, tho it was not a fine Stone to look on, notwithstanding its being transparent in those Edges that were thin. This being reduced to very fine Powder (but not in an Iron Mortar, lest should take something from the Metal) we exactly mixt Eight Grains with an Ounce of finely pulverized Chrystalline Glass; afterwards the Mixture was kept two hours in a Furnace, that gives a stronger Fire than ordinary VVind-Furnaces, by which means we obtained, as I expected, a pretty uniform Mass tinged of a sufficiently green Colour, such as prepared Iron, or Steel, gives to pure Glass.

CHAP. VIII.

WHat has been hitherto delivered, may serve to shew, in some measure, the Uses of our Hydrostatical Way of examining Drugs, upon a Supposition that they are Solid, and neither very minute, nor too light to sink in Water. But I must not forbear to confess, and even

give

give Notice, that there are many Simples, and other ponderable Substances, that may, upon good Grounds, be said to belong to the *Materia Medica*; which yet want One, or More, of the newly expressed Conditions. Wherefore I must not conceal, that there are Three things, which, tho' not necessary to the Understanding of the Usefulness of the foregoing Part of this Discourse; may, if they can be performed, much conduce to Facilitate (for I dare not say, to Compleat) the Hydrostatical Way of examining Bodies, heavier *in Specie* than Water. And therefore, tho' I confess it no easie Task to surmount the Difficulties to be met with in this Attempt; yet I shall endeavour to lessen them as much as I can, by offering to you the Expedients, that I was wont formerly to make use of in the Three Cases, I am about to mention: Namely, *First*, When the Body to be examined was Liquid, and consequently, I could not be immediately taken hold of by an Horse-hair, or

any

any other ſlender String. *Secondly*, When the Body propoſed was either in the Form of Powder, or conſiſted of Fragments that were ſo ſmall, that it 'twas not poſſible, or, at leaſt, not fit, to faſten each of them to an Hair; and ſuſpend it after the manner of a Body of a greater Bulk. And, *Thirdly*, When the Solid to be Hydroſtatically examined, though great enough in Bulk to be tyed about, was diſſoluble in Water; and conſequently unfit to be weighed in that *Medium:* Since therein its Gravity muſt continually decreaſe, whilſt the Operation was performing.

As to the Firſt of the Three Difficulties; lately mentioned, I ſuppoſe, I need not ſolicitouſly premiſe, that the Liquid Subſtance, to be Hydroſtatically examin'd, ought to be heavier *in Specie*, than the Water, or other Fluid, 'tis to be weighed in; and of ſuch a Nature, as not to be apt (at leaſt, ſpeedily) to mingle it ſelf with it: ſince, otherwiſe, the propoſed Liquor will either emerge in that

that it ſhould be weighed in, or elſe be confounded with it, and ſo retain no diſtinct Maſs, or Gravity.

Suppoſing then, that the Liquor, to be examined, has belonging to it the Two newly recited Conditions, we made uſe of this Expedient to explore its ſpecifick Weight. We took a ſmall Jar, or wide-mouthed Glaſs, capable of containing an Ounce or two of common Water, and weighing in the Air about, Three or four Drams (more or leſs, as occaſion requires.) This Glaſs, which, for Brevities ſake, we are wont to call Hydroſtatical, or elſe Glaſs-Bucket; we weigh very carefully once for all, firſt in the Air, and then in the Water, and by the difference of the Weights we find, according to the known Hydroſtatical Method, a Weight equivalent to That of the Subſtance of the Glaſs in Water; ſo that ſuch a Weight being put into the oppoſite Scale of the Ballance, the Veſſel hanging under the Surface of the Water, may be conſi-

dered

dered as having no Weight at all, that is, no Præponderancy. And conſequently, the Weight of a Body contained in this Bucket may be looked upon, as That of the Body it ſelf in Water, without being increaſed by that of the Veſſel; ſo that, in our Inſtance, the Bucket makes a Maſs of Quick-ſilver, tho' Fluid, as ponderable as if 'twere coagulated into a Solid Body.

The Glaſs-Bucket being thus provided once for all, we put the propoſed *Mercury* into it, and weigh them together in the Air; whence deducting the already known Weight of the Veſſel it ſelf in the Air, the Reſidue gives the Weight of the Quick-ſilver alone in the Air. This done, by the help of an Horſe-hair, we tye the Bucket to one of the Scales, (or to either end of the Beam,) and letting it, with the Quick-ſilver in it, ſlowly ſink into a Glaſs, or other Veſſel, competently full of fair Water, and hang ſo, that the Bucket may not any where touch, either

either the bottom, or the sides of the larger Vessel; we reduce by Weights, put into the opposite Scale, and added to the formerly mentioned Counterpoise of the Bucket in the Water, the Ballance to an exact *Æquilibrium*, without raising the Bucket quite to the Surface of the Water; this newly obtained Weight, of the immerst Quick-silver, being deducted from its Weight in the Air, 'tis easie, by the known Hydrostatical Method, to obtain the Proportion in Gravity, between the given *Mercury*, and an equal Bulk of Water.

To expedite this Operation, it may be convenient to have in readiness (as I was wont to do,) a couple of Weights, of Lead, or Tin; the greater exactly equal to the Weight of the Glass-Bucket in the Air, and the other equal to the Weight of the same Bucket in Water. For, by keeping these two Weights constantly in readiness, One has at hand a Counterpoise of the Vessel, in which soever of the two *Medium*'s 'tis employ'd

in; which saves them, that have frequent occasion to use the Ballance much of the time that must otherwise be spent to adjust it.

This Advertisement being premised, the lately propounded Operation will be best understood by an Example; we took a small Glass-Jar capable of holding about ℥ss of Water, and put it into one Scale of a tender Ballance; whose other Scale was furnisht with a Counterpoise, or Weight, equal to the Glass. Into this little Vessel, we then put ℥ss, that is, Four hundred and eighty Grains of *Mercury* (affirm'd to be *Spanish*, which is counted the richest) and the Glass with this *Mercury* in it was, by an Horse-hair, made to hang from one of the Scales, into a deep Glass Vessel of Water. Whilst it was in that state, there was in the opposite Scale a Counterpoise to the Glass it self in the Water, so that the Drams and Grains, that 'twas requisite to add, gave us the Weight of the Quick-silver only, the Weight

of the Glass, being already accounted for. But Care was first taken, that the open-mouth'd Vessel should be every where environed with Water, and diligently freed from adherent Bubbles; and that a piece of Horse-hair should be added to the Counterpoise, to compensate that part of the String or Hair tyed about the Bucket, that was in the Air, intercepted between the Scale, it was fastened to, and the Surface of the Water. By this means, we found the Weight of the Quick-silver in that Liquor, to amount to 446 Grains, which being substracted from the Weight of the Quick-silver in the Air, the difference was 34 Grains, by which the greater Number being divided, the Quotient was 14 and about $\frac{1}{17}$. So that the *Mercury*, imploy'd in this Operation, appeared to be in Gravity to Water of the same Bulk, as $14\frac{11}{000}$ to 1. I said, the *Mercury* imployed in this Operation, because, in former Tryals, I scarce found common Quick-silver,

that was bought in Shops, to weigh full Fourteen times, and sometimes scarce 13 and ½ as much as a Bulk of Water equal to it; whether the Ponderousness of our last used Mercury proceeded from hence; that, as some Chymists extol *Spanish* Mercury, as participating more than others of a Golden Nature, (which Opinion, a Tryal, that I purposely made of That imploy'd about the late Experiment, did not disfavour; *So*, there was in this of Ours something of unfixt Gold, that somewhat increased its Weight; I leave to further Enquiry.

If you can command, as I cannot, the Learned *Ghetaldus*'s *Archimedes Promotus*: Since, as I am informed, He there sets down the intensive Weight of Quick-silver Hydrostatically found; it may be worth your while to consult that scarce Book, and compare the things you may meet with there, relating to Quick-silver, with what I have now delivered. To which I shall add

That

That this I may here give you Notice of in general; That, having on Chymical and other Accounts, had more occasion than most Men, to make Tryals of this sort, I did not find all running Mercuries, tho' they did not appear adulterated, to be precisely of the same Weight: Nay, even destilled Mercuries, if once combin'd with Metalline Bodies, and particularly, if they were animated, and drawn from fine Gold; I found to differ more from common Mercuries sold in Shops, than These did from one another; and even between common Mercuries, notwithstanding their having been Destilled, we found a notable Disparity. But to inlarge on this Subject, were improper in this Place, where I mentioned the Weight of Mercury: But to give so clear (tho' but single) an Instance of the Way of measuring the Weight of ponderous Liquid Bodies in Water, as may warrant me to say; That, by this Method, tho' not always with the same ease, we may explore the spe-

cifick Weight of other Liquors, that are in equal Bulk heavier than Water, and yet are indiſpoſed to mingle with it; ſuch as are the Chymical Oyls of Cinnamon, Cloves, *Guajacum*, &c. But the chief thing, that has made me the the more Circumſtantial in delivering the foregoing Experiment, was, that this practical Direction, for weighing one Liquor in another, will hereafter appear to be appliable to uſeful Purpoſes, eſpecially when we come to mention, in the following Chapters, ſeveral Caſes, wherein Liquors of a Nature very different from Water, may be ſubſtituted in its ſtead.

CHAP. IX.

AS for the Way of Examining Hydroſtatically the Powders of ſinking Bodies, ſuch as *Minium*, *Putie*, &c. or ſuch ſmall Solids, or Fragments of greater Ones, as by reaſon of

of their Littleneſs or inconvenient Shape, are *ſingly* unfit to be tyed with an Horſe-hair to the Ballance; as the Fragments of Rubies, and other precious Stones, wont to be ſold by Weight at the Drugſters or Apothecaries Shops: the Way of diſcovering the Weight of theſe in Water, differs not much from That lately delivered of weighing Quick-ſilver in that Liquor. For on theſe occaſions alſo, we imploy ſuch a Glaſs-Bucket, as was lately deſcribed; and having made it very dry, as well within, as without; We put into it the Metalline *Calx*, or other heavy Powder, or a convenient Quantity of the Fragments of Gems, or a competent Number of ſmall, tho' intire, Bodies, as Pieces of Native *Cinnabar*, *Seed-pearl*, *&c.* and proceed with theſe, as we did with Quick-ſilver. Only this Caution is to be heedfully taken along, that we warily, and little by little, put into the Bucket, whilſt 'tis yet kept in the Air, and hath the already weighed Powder, or Frag-

ments in it, a convenient Quantity of the ſame Water, 'tis to be weighed in; that the Liquor may have time to inſinuate it ſelf between the dry Bodies, and even the *Corpuſcles* of the Powders, and expel thence the Air, that was harbored in the Intervals betwixt them; which little *Aerial* Portions, if not thus ſeaſonably expelled, would, upon the immerſion of the Veſſel, produce in the Water ſtore of Bubbles, that would buoy up, or faſten themſelves to the Fragments, or other ſmall Bodies, and make the Experiment uncertain, or fallacious. And if it be a *Powder*, that is to be weighed; unleſs it be before hand throughly wetted, and thereby freed from *Aerial* Particles, and reduced to a kind of Mud; there is Danger, that ſome dry *Corpuſcles* of the Powder, will, when the Veſſel is under Water, be buoy'd up, and get out of it, and, floating on the Surface of the incumbent Water, take off from the true Weight, that the immerſt Powder ſhould have in that Liquor.

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If this Way of examining Bodies be carefully imployed by a dextrous Man, furnished with a tender Ballance, it may be of considerable use, not only to Physicians, Druggists, and Apothecaries, that are conversant with the more precious Kinds of sinking Bodies, that belong to the *Materia Medica*; but also to Lapidaries, and Gold-smiths, whom it much concerns not to be imposed upon by counterfeit Gems, or by other Stones of price, that are not duly conditioned, in their kind. Thus the Fragments of the *Five precious Stones*, That (upon what grounds, I now inquire not,) are made Ingredients of some Noble Compositions, as *Confectio Hyacinthi*, &c. these Fragments, I say, may each sort of them apart be usefully examined by their Weight in Water, by him that knows the true specifick Gravity of a parcel of the finest, or else of such as he judges to be fittest for his purpose. And, to add That upon the By, whereas *Granates* are reckoned among the

Five

Five Medicinal precious Stones, and in some *Pharmacopœa's* are preferr'd to the First place, as the best: I have found so great a difference, in point of Ponderosity, between *European Granates* and *American* Ones, whereof some were sent me as a Present from *New England*, and others, I my self pickt plentifully enough out of an odd *American* Mineral, that I suspected to contain them; that it was very obvious to think, their Virtues might be very different, if not as to *Kind*, yet, at least, as to *Degrees*: And *not only* such factitious Pearls as have deluded many, and sometimes even famous, Jewellers, (as one of themselves, that was Lapidary to a great Monarch, confessed to me) may oftentimes by this Expedient be discovered, especially if Mercury (tho' disguis'd) be imploy'd in making them; *but*, we may probably by the same Method discriminate the natural Pearls of several Countries and Sorts, whereof I have seen a far greater difference than one would expect; and

and I have somewhere yet by me natural Pearls of such various Colours, as well as Shapes, as have somewhat surprized even the Curious. But because it more concerns Physicians and Patients, to be able to make Estimates of Seed Pearl, that are on many occasions of good use to health; than to know the Genuineness of those bigger Ones, that are seldom made use of, but for Ornament; I shall here mention the result of an Experiment, which I find among my old Notes, to have been made by me, when I was furnished with very fine Oriental Seed-Pearls. For having examined these by the Way, we are now discoursing of, as judging them Orient enough to be fit to be Patterns, wherewith to compare Others; we found these to Water of the same Bulk, 2 $\frac{75}{100}$ (*i. e.* $\frac{3}{4}$) to 1.

But in This, and in those other Tryals, whose Difficulty, or Importance, require, that we make them as exactly, as we are able. I must advertise you, that 'tis not fit to trust to

to the Steddineſs of your hand, in holding the Ballance, but that you make uſe of a Gibbet, (as they call it,) or ſome other ſtable Prop to ſupport it. For the Hand often ſhakes, and makes the Inſtrument that it holds, to do ſo: and oftner grows weary before the Scales have had time to play up and down, and at length ſettle in a determinate Scituation; wherein if you miſs of a true *Æquilibrium*, the Hand muſt undergo a new Pennance: Whereas, when the Ballance hangs on a ſtable *Fulcrum*, you have both your Hands to help you, and need not be tempted by Wearineſs to deſiſt, before the Ballance be brought to reſt in a perfect *Æquilibrium*. The Neglect or Omiſſion of this Practice, I take to be one main Reaſon, (for the want of good Ballances, or of Skill to uſe them, is oftentimes Another) why ſo many of the Experiments, that require weighing, are Erroneous; as they that cautiouſly examine them (as I have ſometimes had occaſion to do)

do) may easily find. And therefore, (to add That, upon the By,) I hope, you will not make haste to censure the Accounts I give of Hydrostatical Tryals, because they do not always agree with Those of other Mens; since perhaps they did not imploy, either more Diligence, or better Instruments, than I.

CHAP. X.

THe last of the Three Cases, formerly mentioned: Namely, *What is to be done, when the Body to be Hydrostatically examined, will dissolve in Water, or easily mingle with it?* Imports a Question, difficult and troublesome enough to be resolved. Nor can this *Examen* be performed by a single Operation, which yet sufficed in each of the Two foregoing Cases. And having seriously considered the Matter, the best Expedient I could then think of was, That, which divers

vers years ago, I propounded in an Aſſembly of the Royal Society, and grounded on this Reflection, That tho' the Body propoſed could not be immediately weighed in Water, yet we may ſubſtitute another Liquor that will not diſſolve it, and thereby inveſtigate the ſpecifick Gravity, in reference to *that Medium*; and then, by comparing the difference of thoſe Two Liquors in point of Gravity, One may come to diſcover, What the Body propoſed would have weighed in Water, in caſe it could have been kept there a competent time, without having any part of it diſſolved. Conſidering then, that, except Quick-ſilver, the viſible Fluids we can command, are either of an *Aqueous*, or of an *Oily*, Nature; and that moſt Bodies, whereof we can make Solutions in Liquors of the former, will not (at leaſt, ſenſibly) ſuffer themſelves to be diſſolved by thoſe of the later, Kind, whilſt a propoſed Solid is weighing in them: We preſum'd that the moſt Saline Bodies, ſuch

ſuch as *Allum*, *Vitriol*, *Sal Gem*, to which may be added, *Borax*, *Sublimate*, &c. might be commodiouſly weighed in *Oleous* Liquors. Among theſe I made choice of Oil of *Turpentine*, rather than Oil-*Olive*, or any Chymical Eſſential Oil: *Partly*, becauſe, being of common uſe, 'tis to be procured in ſufficient Quantity, and, being very cheap, is ſeldom adulterated, as Chymical Oils are too often found to be; and, *partly*, becauſe being a diſtilled Body, it may be preſumed to be free from *Aqueous* Parts, of which Experience has ſhewn me, that common expreſſed Oil is far from being deſtitute: But becauſe Two Liquors, that are indeed both of them Oils, are wont to have diſtinct Names given them in the Shops; I ſhall here intimate, that I do not, when I have my Choice, make uſe of that which many call the *Oil* of *Turpentine*, but of That which firſt comes over, which thoſe that diſtinguiſh them, call the *Spirit* of *Turpentine*: I prefer This,

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(I ſay,) becauſe 'tis clear, almoſt like fair Water; whereas, That which is called the *Oil*, beſides that 'tis leſs Fluid, is commonly of a Yellow Colour, which does leſſen its Tranſparency, and may be compounded with ſome of the coloured Bodies to be weighed in it.

There are many Perſons, that would find it very *difficult*, and to whom, on moſt occaſions, 'twill not be *neceſſary*, to know the determinate Proportion in Gravity, between *Oil* of *Turpentine*, and the Solid that is weighed in it; and to diſcover, by the help of that Gravity, what the Body propoſed would weigh in Water, in caſe it could be kept for a competent time in that *Medium*, without having any part of it diſſolved therein. And therefore, *Tho'*, if you deſire it, I ſhall, God permitting, annex the Method of performing this Task (which, you know, requires more Calculation, than every common Reader is able to go thorow with) to the end of this Tract: *Yet*, for

for the present it may perhaps be sufficient, as well as fit, that I give you notice, that those, that have not Skill enough to determine, by the Hydrostaticks, the Proportion between sinking Solids, and the Liquor they are weighed in, may yet be assisted by what we have delivered about *Oil* of *Turpentine*, to make a not unuseful Estimate, What is the specifick Gravity of divers Bodies, in reference to others of the same, or a differing, *Species*; and by that means, to make a probable Guess, Whether or no it be rightly Conditioned; if he be but provided with one piece of the Body, which he knows to be Genuine or well qualified. For This may serve him as a Standard, whereby to examine other Bodies of the same Denomination, that he may have occasion to Purchase, or to Sell, or to Imploy. As, suppose a Trades-man be to buy a parcel of Sublimate, he may take an Ounce, for instance, or half an Ounce of some of That he knows to be good or rightly made: Then having

carefully weighed it in *Oil* of *Turpentine*, and ſet down how much it weighs therein; if he takes an Ounce, or half an Ounce of the Sublimate, he would make Tryal of, he may weigh that, as he did the other, in the ſame Liquor, wherein if it give the ſame Weight with the Standard, 'tis a good Sign; but if it weighs not ſo much, 'tis a Sign that it has not its full or due Proportion of *Mercury*, and too great a Proportion of Salts, whence its comparative Lightneſs proceeds. The ſame Way of trying may be made uſe of, for the *Examen* of *Mercurius Dulcis*, and divers other Bodies, totally or partly, diſſoluble in Water, as of *Allum*, which is often Sophiſticated with ſome baſer Salt, and of *Roman Vitriol*, which is ſometimes either counterfeited, or adulterated by the help of *Roch Allum*, and a Tincture of *Copper*. And according as the Weight in Oyl of the Body propoſed, recedes more or leſs from the Weight of the Standard, ſo the Adulteration may be probably conclu!ed to be leſſer or greater.

CHAP.

CHAP. XI.

BEfore I go off from this Subject, 'tis fit that I give you notice, that the Hydroſtaticks may ſupply us with another Way of Eſtimating the intenſive Gravity of Bodies, Solid or Fluid, that may on ſome occaſions be of good uſe. The Way I mean is this; we take a ſolid Body more than heavy enough to ſink in Water, and carefully obſerve, once for all, its Weight in the Air; then we weigh the ſelf ſame Solid, firſt in One of the Liquors we would examine, and then in another; and ſo onwards, if there be more than two: And having noted the difference between the Solid, and each of the Liquors, 'tis eaſie to find, according to the Practice elſewhere delivered, the ſpecifick Weight of each, and the Proportions betwixt

them. And in regard 'tis but One and the same Solid, that is compar'd to the differing Liquors; whatsoever their Number be, it will not be difficult, to compare the specifick Gravities of those Liquors betwixt themselves, and to discover by the Weight of the *First*, That of any of the Others that One pleases.

The propos'd Way having been but Summarily delivered, it will not be amiss to subjoyn some Remarks relating to it.

And *First*, If you intend to imploy but One Solid in your *Examen* of Liquors, 'twill be necessary you make Choice of such an one, as hath a much greater specifick Gravity, than is necessary to make it sink in *Water*. For there are some Liquors that are far, perhaps twice, more ponderous than This newly named. *Secondly*, The Body ought to be heavy enough to sink in all Liquors but Quick-silver, (for in That, none but Gold is ponderous enough to sink.) But if your Tryals are to be made upon

upon Liquors that belong to the Vegetable, or Animal, Kingdom, the Body you imploy need not be near so ponderous; tho' it ought to be more so than Water, because (as I found by Tryals purposely made) some Liquors, that are very Spiritous and Volatile, are yet much heavier *in Specie*, than Water. 'Tis not very easie to pitch upon such a single Solid, as may have all the Qualities in reference to our Purposes, that may be desired in it, if it be to be made use of for a long time. For *Thirdly*, Besides that, it ought not to lose of its Weight, (and consequently to change it,) by the insensible Avolation of *Effluvia*, and that it must be, as was freshly noted, of a considerable specifick Gravity. *Fourthly*, It ought not to be too big, or too intensely heavy, lest it be too heavy for a tender Ballance, or require too much Liquor to inviron it. *Fifthly*, It ought to be of such a Texture as not to be dissolved, or corroded by any of the several Liquors, some

of which may be sharp and piercing *Menstruums*, that 'tis to be weigh'd in; and those too of differing Natures. *Sixthly*, It should also be of such a Make, as is not easily lyable to be broken, or otherwise spoil'd, that it may last, till all the design'd Experiments, tho' many, be made with it. *Seventhly*, and lastly, 'tis desirable, that it should be of a natural and uniform, as to Sense, and procurable Substance; that the Experiments, made with it, may be easily enough communicated to Others, and, if they think fit, tryed over again by them; and that, if any be judged worthy, they may be transmitted to Posterity.

Several Bodies there are, that I looked upon as more fit than most Others to be imploy'd about the Tryals, we are treating of. The chief of these were *Brimstone*, *Hard Wax*, *Ivory*, and *White Marble*. But tho' each of these, especially if fitly shaped, may be of use on some particular occasions; yet every one wanted

ted some of the desirable Qualifications lately mentioned. And therefore, I made much more use of Three other Bodies, not because they were such as I could Wish; but because they were the least remote from being such, among those I could Procure. The *first* of these was a piece of *Amber* between Three and Four Drams in Weight, of an high Yellow Colour, but very Transparent, and of an uniform Texture and convenient Shape. This was judged fit to be imployed, when we were to examine the lighter sorts of Liquors, such as common Water, Rain-water, *&c.* Wine, Brandy, rectified Spirit of Wine, Vinegar, and the Liquors drawn from it, Cydar, Beer, Ale, Urine, many Waters and Spirits destilled from Bodies belonging to the Vegetable, and to the Animal, Kingdoms. But 'tis not proper for the more ponderous kind of Liquors; since 'twill not sink to the Bottom, but float at the Top, not only of some Liquors of the Mineral Kingdom, (as will

ere long appear;) but in ſeveral Liquors afforded us by the Saline parts of Bodies belonging to the Vegetable Kingdom; as you will find within a few Pages.

The Second Body, I imployed, was a *Globular* Glaſs, which I cauſed to be blown at a Lamp, and to be Hermetically ſealed at the Neck, which was purpoſely made very ſhort, after there had been Lodged in it as much Quick-ſilver, and no more, as we gueſſed would ſerve to ſink it in any Liquor, except Quick-ſilver; This, by reaſon of its great Bulk, in reference to its Weight, was fit to diſcover Differences in Weight, minute enough between the Liquors 'twas weighed in; and 'twas out of Danger of being corroded, even by ſharp *Menſtruums*; and therefore, on divers occaſions, I preferred this Inſtrument to any of the other Two; but 'tis diſadvantag'd by theſe Inconveniencies, *that* 'tis difficult to be made, or procured, *that* 'tis hard to be preſerved, being very eaſie to be

be broken, and *that* partly on this Account, and partly on Others, it can ſcarce be a fit Standard in reference to ſuch Obſervations, as are to be communicated to Others, and tranſmitted to Poſterity.

Wherefore for Experiments that are to be imparted & recorded, I made uſe of a Solid, which *tho'* heavier *in Specie* than was neceſſary to inable one to compare together the lighter ſorts of Liquors, and to diſcover their minuter Diſparities in point of Weight, is yet a natural Standard not ſubject to be broken without groſs Negligence, nor to be diſſolved, or corroded by the Liquors, 'twas to be immerſt in, however of various Kinds, and very ſharp, and ponderous enough to ſink in all of them, except Quick-ſilver, and yet not near ſo ponderous, as the lighteſt Metals, or many Metalline Bodies; this Solid I ſpeak of is Rock Chryſtal, which I formerly repreſented, as for its Purity, Homogeneity, *&c.* fit to afford a Meaſure, to which other Bodies

Bodies may be compar'd in Weight, and by that means among themſelves. And of this pure Concrete, we imployed an almoſt compleat Globe, (weighing in the Air ℥ij ʒſſ Grains 3,) ſave that it had in one part of it two ſmall Holes near one another, and eaſily ſtopt up with hard Wax, after there had been put through them an Horſe-hair, by whoſe means the Ball was eaſily faſtened to the Scale from whence 'twas to hang in the Water. The bigneſs of this *Globular* Body made it the more fitto diſcover the leſſer Differences between Liquors in point of intenſive Gravity. But becauſe we may have oftentimes occaſion to know the Weight of Liquors, of which, by reaſon of their Precioufneſs, or Rarity, we can command but ſmall Quantities, as it frequently happens, if we be to try the Weight of Chymical Oyls, Tinctures, Eſſences, &c. We thought fit, for ſuch Liquors, to provide a piece of Chryſtal, ſuch as Nature had framed it, *viz.* an *Hexagonal Priſme*,

Prisme, with a kind of Pyramide at the end, which is oppoſite to the extream, at which 'twas broken off from the Body, it grew on. For this clear and finely ſhaped Chryſtal, (or, what is very near of kin to it, white *Amethyſt*) by reaſon of its oblong Figure, might be commodiouſly weigh'd in ſo ſlender a Cylindrical Glaſs, as required but a ſmall Quantity of Liquor to cover and ſurround a conveniently ſhap'd Body, that weighed, in the Air, but half an Ounce and ſixteen Grains. And to render the Obſervations, made with theſe two Bodies of Medicinal and other Liquors, (for there are ſeveral of theſe Tryals, that belong not to this Tract) the more uſeful to Experimenters, I ſhall here deſire you to take notice once for all, that the Ball of Chryſtal was to Water of the ſame Bulk, as $2\frac{57}{100}$ to 1 or thereabouts; and the Priſmatical Oblong piece of Chryſtal was to a Quantity of the ſame Liquor, equal to it in Magnitude, as $2\frac{66}{100}$ to 1.

I have the more particularly delivered the Way of exploring the Gravity of ſeveral Liquors with one Solid, becauſe there may be made of it a couple of Applications, that may, on ſeveral occaſions, be of uſe, not only to Chymiſts, Phyſicians and Apothecaries, but to divers other Experimenters, that are not of either of their Profeſſions.

Theſe Applications do, I confeſs, belong to another Paper, (*viz.* an Eſſay about ſome Uſes of Chymiſtry improved) that was written divers years ago. But ſince, by reaſon of the loſs of divers Leaves of it, I know not *whether*, much leſs *when*, 'twill come abroad, I ſhall at preſent borrow ſome few things of it to accommodate my preſent Deſign.

Firſt then, the piece of clear *Amber* formerly mentioned, or ſome ſuch convenient Body, that is not too little, nor *in Specie*, too heavy, may ſerve the Chymiſt, Apothecary, and others, to make probable Gueſſes of the Degree of Spirituoſity, or of Thinneſs,

neſs, that is to be found in many Liquors belonging to the Vegetable, or the Animal Kingdom; which may be done with far leſs Error by this Way, than by thoſe uncertain Signs, on which the common Ways of gueſſing are wont to be grounded. For having once provided a Liquor, by Compariſon whereto One may ſafely make Eſtimates of Others of the ſame Kind, or Denomination, 'twill be eaſie, by obſerving the differing Weights of the *Amber* in ſeveral Liquors to judge of the Fineneſs of any of them in its Kind; for, *Cæteris paribus*, That is the thinneſt, or abounds moſt in Spirituous parts, where the Solid weighs more than in the Other, as for inſtance, The *Amber* we imployed, that in Water weighed 6 ¼ Grains, in common Red French Wine weighed 8 ½ Grains, in common Brandy of a pretty good ſort, ſuch as that of *Nantz* 13 ¼ Grains, and in vinous Spirits highly rectified 34 ½ Grains. The ſame Way one may imploy, to judge of the

the Strength of Spirits of Vinegar, *Acetum Radicatum, &c.* but with a great difference in the Application. For it may pass for a general Rule, That, 'tis probable, that, of Liquors destilled from Wine, Cydar, Ale, and other fermented Liquors, the Hydrostatical Body (if I may so call it) weighs more or less, according as the Liquor 'tis weighed in, is more or less Spirituous; but, on the contrary, in *Acid* Spirits and Liquors, the less the Solid weighs, the stronger One may repute that Liquor to be: That greater Decrement of Weight proceeding usually from the greater Proportion, it contains, of Salts that are not Volatile.

I must not here pretermit one Convenience of the Way newly proposed, that may, in tract of time, save you some Money, and, at least, will enable you to Husband better, than in the vulgar Method you can, Liquors that you may have but small Quantities of, or that are worthy to be preserved. For, you know, 'tis usual

usual with many Chymists, and especially those that are more circumspect than others, to try the Goodness of their Spirit of Wine, or Brandy, or other Spirits drawn from fermented Liquors, by setting Fire to a spoonful of the Spirit to be examin'd, in order to see, how much of it is totally inflammable, and how great, or little, a Portion of Phlegm will be left behind. But, not here to mention the Scruples I propose in another Paper, about this Way of trying Ardent Spirits, I shall now only take notice, that, by the newly recited Way, you lose or spoil all that you try, and the better the Spirit is, the greater is your Loss, whereas by the Hydrostatical Way, the Liquor is examined without being destroyed.

'Tis now fit to add, that, by the help of the foregoing Observations, One may also make Estimates of *Liquors* of the same kind *not destilled*, whether fermented or not fermented; as several Sorts of Beer, or of Ale, or of Cydar,

Cydar, or of Juices of Apples, or of Pears, newly prest out. And the same Hydrostatical Solid may be imployed, to compare with one another, in point of intensive Weight, Liquors of differing kinds, as Wine, Beer, Ale, Mead, Cydar, Perry, Verjuice, expreſt Oyls, Essential Oyls of differing Bodies, *&c.*

But, in case the Liquors to be imployed be very ponderous, *Amber* will not be a fit Solid to be examined about them; for I have found by Tryal, (what one would scarce suspect) not only that it would swim or float, in divers Liquors made by Solution of Salts, whether in the moist Air, or even in Water, such as Oil of *Tartar per Deliquium*, Solution of Salt of *Tartar* in as little Water as may be, and Solution of the Salt of Pot-ashes, *&c.* But some destilled Liquors would not suffer my pellucid *Amber* to sink to the Bottom, as I found by Tryal made with Oil of *Vitriol*, with Spirit of *Nitre*, and even with good Spirit of *Salt*.

Besides

Besides, there may be another Use made of our Hydrostatical Solid, which may, on divers occasions, be *as* Serviceable to Experimenters in general, by assisting them to proportion, to their purposes, the Strength of the *Menstruums*, and other Liquors, they are to imploy; *as* the former use is to Destillers and Apothecaries, for discovering the Strength of the already prepared Liquors, that they would examine. For there are divers Experiments, that either do not succeed, or, at least, do not succeed so well, unless the *Menstruums*, or other Liquors, imployed in making them, be of a determinate Degree of Strength, (which is usually knowable by a certain Degree of intensive Weight.) This will be the more easily granted, if (as I have elsewhere shewn) the Strength and Spirituosity even of some Liquors, whose chief Virtue and Use is to be good Solvents, may yet be unfit to dissolve, as well because their Strength exceeds a certain Mea-

sure, as because, by their Weakness, they fall short of it; Of this, I remember, I gave an Instance in *Aqua Fortis*, whose strength, as it's Name intimates, is reckon'd the best Quality it can have; for I found, that if it were rectified so much as to make it as strong, as we could, or but somewhat less strong than that, it would not dissolve Silver, but required to be weakened by an Addition of Water; and I found, that the *Menstruum*, tho' it were not much rectified, would not near so well dissolve the Filings or Raspings of crude Lead, when 'twas moderately strong and fit to dissolve Silver, as when 'twas allayed with a considerable Quantity of Water, especially if afforded by Rain, or by Destillation. I shall add, that, in making Extractions from many vegetable Substances, for Medicinal Uses, Chymists themselves may fall into a Mistake, when they affect to employ their most rectified Spirit of Wine, as the best *Menstruum* for their purpose:

For

For the Medicinal Virtue of not a few ſuch Bodies does not reſide only in what Chymiſts call their *Sulphur*, and might perhaps more properly be called the Reſinous Part, which indeed is beſt diſſolved by ſuch Spirit of Wine, as is carefully dephlegm'd; but alſo in a more Gummous, and, partly perhaps, almoſt Mucilaginous Subſtance, for whoſe Extraction a moderately Phlegmatick Spirit is more proper; becauſe of the Aqueous Portion, that is mingled with the inflammable One; ſince we ſee, that ſome Gummous Bodies, as *Gum Arabick*, *Gum Tragacanth*, &c. are not diſpoſed to be diſſolved by the beſt rectified Spirit of Wine, as they are by Aqueous Liquors, as Water, weak Spirit of Wine, &c. and ſome, tho' diſſoluble in both kinds of *Menſtruums*, are yet leſs eaſily ſo in ſtrong Spirit of Wine, than in wateriſh *Menſtruums*; as may be obſerved particularly in *Myrrh*; for other Inſtances applicable to theſe Adver-

tiſements belong to another Paper.

And what has been now ſaid, may ſerve to perſuade you, that it may be of good uſe, on divers Occaſions, to take Notice of the Degree of Strength of the *Menſtruum*, or other Liquor, we employ about this or that nice Experiment; that when we have occaſion to reiterate it to the ſame Purpoſe only, we may be able to bring the Liquor we make uſe of to the ſame Degree of Strength with That, which we formerly emyloyed, and by which the deſign'd Effect was produced. But, in Experiments that ſhould be very Critically made, 'twill not be amiſs to bear in mind this Caution, that if the Liquor be very ponderous *in Specie*, as *Oil* of *Vitriol*, or *Oil* of *Tartar per deliquium*, 'twill be fit to put ſomething into the Scale, from which the Solid hangs, to make Compenſation for that part of the Hair that is immerſed, ſince Horſe-hair not being of the ſame Specifick Gravity with this Liquor, (tho' it be preſumed

ſumed to be ſo with common Water) is to be conſidered, as a ſomewhat lighter Body, capable of buoying up the Solid a little; and therefore its Comparative Levity ſhould be compenſated.

CHAP. XII.

BEſides the Way, we come from diſcourſing of, there is indeed another Way, which we have, on divers Occaſions, found uſeful, to compare different Liquors, that are of the ſame Magnitude, in point of Weight. This is done by ſucceſſively filling a Vial greater, or ſmaller, furniſhed with a pretty long and ſlender Cylindrical Stem, to a certain ſtable Mark made near the Top, with the ſeveral Liquors to be compared together in point of Gravity.

But this Way I muſt here do no more than name, not ſo much becauſe I ſpeak of it in a convenient

place of another Paper, as becauſe 'tis not Hydroſtatical. But there is alſo another Way to diſcover, Whether or no, Two, or more, Liquors propoſed differ in Specifick Weight, and to make ſome, not groundleſs, Eſtimate of their Differences. This is done by a hollow Cylinder of Braſs, or other Metal, made ſomewhat heavy at the bottom to make it ſwim upright, that ſinks more, or leſs in ſeveral Liquors, as they are lighter, or heavier, one than another. But the diligent *Merſennus* himſelf, who propoſes this Way, confeſſes it to be very difficult to make ſure Obſervations by it. To which, I ſhall therefore add but this, that, being a Metal, it may be corroded by Acid *Menſtruums*, and if it be of Braſs, or Copper, it may be wrought upon or injur'd by Urinous *Menſtruums*, too.

What *Merſennus* ſaid of this Inſtrument, may be applied to another, tho' differing from it, both in Shape and Matter. For 'tis made of

two

two Glaſs Bubbles, and a very ſlender Stem, which is Hermetically Sealed with a Ballaſt in the lowermoſt of Quick-ſilver, to keep it ſteady, when partly immerſt in Liquors, in which this Inſtrument, like the Metalline Cylinder, ſinks deeper in lighter Liquors, than in heavier, in a meaſure ſomewhat anſwerable to their Differences in Gravity. But, tho' I have, on ſeveral occaſions, employed theſe Inſtruments, and found them not unuſeful, when I did not confine my ſelf to One, or Two, but made uſe of ſeveral of different Sizes, according to the various Liquors, I was to examine; yet what you may elſewhere find about this Inſtrument, diſpenſes me from ſaying any more of it in this place, than that, for ſome of the ends aimed at in this Chapter, it is inferior to the Way of examining Liquors by the help of the Ballance.

There is alſo another Way, that *is* Hydroſtatical, propoſed by *Merſennus*, of weighing of Liquors in

Water, and it is This; He bids you take a Glaſs Vial, to which, being firſt weighed in Air, and then in Water, you are to adjuſt a Stopple of Wax, or Cork, that will fit it exactly. This done, you are to fill the Vial with the Liquor you would examine, ſo that no Air be left between it, and the Stopple. The Veſſel thus filled, you are to weigh in Water, and ſubſtract from its Weight there, the formerly noted Weight of the Glaſs it ſelf in Water, and alſo That of the Stopple; which done, the remains will give the Weight of the Liquor propoſed in Water. This Method I lately chanced to find propounded by (the Writer newly nam'd) the induſtrious *Merſennus* in his *Hydraulicks*; but, I remember not, that he affirms himſelf to have made uſe of it; And tho' it may be ſerviceable on ſome occaſions, yet, I fear, it will be troubleſome in Practice. For, (to omit ſome inconvenient Circumſtances) ordinary Vials, capable of containing

containing a competent Quantity of Liquor, are, usually, too heavy to be imployed with tender Ballances; and common Stopples (such as *Mersennus* may be well supposed to have imployed) will be subject to divers inconveniencies; as, that they may be penetrated by some Liquors, and corroded by others, and if they be made of Cork, or of common Wax, or any other Substance lighter, *in Specie*, than Water, 'twill not be easie to find its specifick Gravity; especially since Evaporation, and other Accidents make this it self vary; and whatever Matter, Vegetable or Animal, it be made of, the Vessel will cost you two Operations, One to discover the Weight of the *Vessel* in Water, and the Other that of the *Stopple*, (at that time) which is troublesome. Wherefore, when I met with this Way in the ingenious *Mersennus*, it seemed to me more inconvenient, than One, that, I remember, I had formerly thought of, and which I have sometimes put in Practice, by chusing

chuſing a Vial not too large, and of a round Figure, that being the moſt capacious under ſuch a Superficies, and, inſtead of other Stopples, fitting it with one of (the like) Glaſs, carefully ground to the Neck of it. For, by this means, the inconveniencies of a Stopple lighter than Water were avoided, nor would the Stopple alter its ſpecifick Gravity, either by Imbibition, or Evaporation, nor would it be penetrated by the moſt ſubtil Spirits, nor corroded by the moſt fretting Ones. To which may be added, becauſe, in ſome Caſes, it may be conſiderable, that a Glaſs-ſtopple, as it will not be wrought on by the Liquor contained in the Vial, ſo it will not communicate any Tincture, or extraneous Quality, to the Liquor, which cannot be affirmed of a Stopple of Cork or Wax, in reference to ſome Subtil and very Corroſive, or otherwiſe very penetrating Liquors, this Hydroſtatical Bottel (as for diſtinction ſake I call it) being together with its Stopple carefully

ully weighed, First in Air, and then n Water, (that the Gravity of the vhole Instrument in that Liquor nay be setled once for all) we fill'd t exactly with the Liquor to be examined, and so proceeded, as we if were o weigh Quck-silver according to the Manner formerly declared in the Eigth Chapter. The Weight of the given Liquor in Water being thus obtained, its Proportion in Weight to Water of the same Bulk may be easily discovered by the Way formerly delivered in the Second Chapter (or the Tenth Chapter.) This way of examining Liquors may, on some occasions, do good Service, and I did the rather, now and then, make use of it, because 'tis applicable to all kind of Liquors, whether heavier *in Specie* than Water, or lighter.

If you lay aside the Stopple, the round Ball it self may be made use of, on several Occasions, instead of that Hydrostatical Bucket, formerly mentioned; for the weighing

of

of Quck-ſilver, and divers heavy Powders; eſpecially if they be Courſe Ones. But if the Inſtrument be fitly ſhaped, and not too heavy, there may belong to it a greater Conveniency than This. For when you have, and are willing to ſpare, Liquor enough to inviron the little Bottle, it may be uſefully ſubſtituted to the Hydroſtatical Bubble, with Quick-ſilver incloſed, that I formerly recommended. For, by reaſon of its exact Stopple, it has no need of an Hermetick Seal, (which is not eaſie to be be made or procured;) and 'tis far leſs Subject to be broken, than a Bubble. And yet that which I moſt made uſe of, (and which weighed about ℥i ʒiii ß. Grains xix, or 709 Grains) being well ſtopt with only Air in it, would ſink by its own Weight in Water, and in Liquors lighter than This, as Wine, Brandy, *&c.* And if it were to be imployed in Liquors much more Ponderous than Water, as *Aqua Fortis*, *Oil of Tartar perdeliquium*, &c. 'twas eaſie to

o make it fit to be weighed in hem alſo; by putting into it a Quantity of Quick-ſilver (or ſome ther fit Body) of a determinate Weight, as two, three or four Drams, efore we ſtopped it: Which Baaſt, when the Operation is over, nay, if it be Quick-ſilver, be eaſily aken totally out, and kept apart or the like Uſes: and the empty Bottle, and Stopple, may thereby ecome fit again, to be weighed in Water and lighter Liquors.

But notwithſtanding all this, beauſe Glaſſes, for ſize, ſhape, and weight, fit for Ballances, tender enough, and furniſht with Glaſs Stopples exactly fitted to them, are very difficult to procure; and the Way it ſelf is ſubject to ſome of the nconveniencies, that we imputed to ther Ways, not long ſince mentioned: t ſeems, that, generally ſpeaking, his Way of finding the Weight of Liquors in Water, is Inferiour for common uſe, to thoſe more ſimple Ones, that we formerly recommended. *See the Chapter.*

CHAP.

CHAP. XIII.

Uſe VI. HAving now laid down the Method of weighing one Liquor in another, 'tis allowable, and may be fit, that we ſubjoyn ſome Application of it: Eſpecially, becauſe it will become me to make good, in ſome meaſure, what, I remember, I formerly hinted to you, *viz.* that, in the ſubſequent part of this Paper, there would be delivered a further Uſe, which may be counted the VIth. of the Hydroſtaticks in examining Medicinal Bodies. And *tho'* by the Inſtances we lately had occaſion to propoſe in ſome of the Chapters preceding This, divers things referable to this Uſe, are ſet down already; *Yet* I ſhould not content my Self, (as I now muſt do) to point at the chief *Heads* or *Kinds* of things referable to it; if, on a Subject that is more fertile, than it ſeems,

want

want of leisure did not restrain me from descending to treat of the particular Instances, that belong to them.

Among the Services then, that the Hydrostaticks may do a sagacious Physician, I must not omit One, tho' it has not hitherto, that I know of, been propounded by any Author. And, I hope, you will not think it improper to be taken notice of here, tho' it do not regard *only* the *Materia Medica*, but is applicable (as I may elsewhere relate that I made it) to divers Subjects, that are referable to other Parts of Physiology: Since divers Bodies, that seem not so directly to regard the *Materia Medica*, as 'tis usually reposited in the Shops of Drugsters, have been, in *some times and places*, and may deservedly be *now* made to afford Matter for Remedies, to a free and ingenious Physician.

I consider then, that there are many Liquors, whose specifick Gravity it may be useful to know, not only, as

it may help to diſtinguiſh Genuine, or well conditioned Ones, from Them that are not ſo, but for other good Purpoſes too.

Inſtances of this kind may be afforded by the Juices of Herbs and Fruits; where (according to the Direction given in the laſt Chapter) we firſt weigh a determinate Quantity, as an Ounce, or ſo many Drams, in our Hydroſtatical Jar, or Bucket; and putting ſome Oil of *Turpentine* on it, we ſink it warily into that Liquor; whoſe ſpecifick Gravity in reference to refined Silver, clear Rock Chryſtal, (or ſome other Body, if we know it to be as pure) has been *carefully* found out and regiſtred: For, by this means, (as we have lately manifeſted) ſubſtituting this Oil for common Water, we may diſcover the ſpecifick Gravity of Liquors, not to be weighed in Water, becauſe they mingle with it. And thus we may find, not only the difference in Ponderoſity between the Juices of Plants

Plants of differing kinds, as of Wormwood and Roſes, and ſometimes of the ſubordinate *Species* of the ſame *Genus*, as of *Abſynthium Vulgare*, *Ponticum*, *Romanum*, &c. and Roſes *White*, *Red*, *Damask*, *Yellow*, &c. but we may on ſome occaſions obſerve, whether, and, if at all, how far, the keeping of a Juice for ſome time, more or leſs, or the Fermentation of it, or the Putrefaction, will alter its ſpecifick Gravity. There are alſo other Liquids us'd by Phyſicians, and not ponderable in Water, that may be by this Way examin'd, as Honey, Vinegar, Verjuice, *&c.* And by the ſame Way may be alſo diſcovered and compared, the ſpecifick Weight of the Juices of Fruits of different kinds, as of Grapes, Apples, Pears, Quinces, *&c. and* of ſubordinate *Species* belonging to the ſame *Genus*; as the newly expreſſed Juices, that make Sacks, French-wines, Rheniſh-wines, *&c. and* thoſe Liquors, that are preſſed out of ſeveral ſorts of

Apples, as Pippins, Pear-mains, John-Apples, Queen-Apples, *&c.* And in divers of theſe, a Perſon that is curious enough, may probably, by the Method we have been propoſing, be enabled to take Notice of the Differences produced in the ſpecifick Gravity (whoſe Changes are uſually accompanied with thoſe of Conſiſtence, *&c.*) in the ſeveral ſucceſſive States, wherein the Liquors may be found at different times; as (not to mention the Juice of unripe Grapes, *viz. Verjuice*) the Juice of ripe Grapes is in very differing States, *when* 'tis newly preſſed out; *when* it begins to ferment; *when* 'tis yet but New Wine; *when* it has attain'd its full Maturity and Perfection; *when* it begins to degenerate into Ropy, prick'd Wine, *&c.* and when 'tis abſolutely changed into Vinegar, or elſe into *Vappa*.

But here it ought not to be concealed from you, That in this kind of Experiments, to make uſe ſucceſsfully of the Hydroſtatical Bucket

is a Task difficult enough, for Reasons that a few Tryals will easily discover. And therefore, tho' I would not discourage the Skilful, yet for those that do not find themselves dextrous at making Experiments, I think it adviseable to imploy, instead of the Bucket, Amber, or some other convenient Hydrostatical Solid; or rather (which is better) a Glass-bottle and Stopple, such as We formerly described; but as large, as may well be imploy'd without over-loading, or injuring, the Ballance.

CHAP XIV.

AS I thought 'twas fit to give the foregoing Advertisement, by way of Caution, in the Cases that occasioned it; so having considered the Nature and Scope of the Hydrostatical Experiments in General, that belong to this Essay; I shall venture

to add for the Encouragement of thoſe, that are better furniſhed with inquiſitive Minds, than with nice Ballances; that *tho'* in divers Tryals, eſpecially Thoſe that are made about precious things, as Gold, Pearls, Diamonds and other Gems; there is no relying upon any, but very Good and tender Ballances; *Yet*, on many other occaſions, 'tis not neceſſary, tho' it be deſirable, that the Scales, we employ, ſhould be extraordinary Good. And this for two Reaſons: *Firſt*, becauſe many Hydroſtatical Experiments are ſuch, that a little Variation from the exact Proportion of the Solid to the Liquor, or between Bodies of the ſame Denomination, can lead us into no conſiderable Error; or, at leaſt, not defeat the Experimenters main Deſign; as, with a Ballance that is not nice, One may ſufficiently diſtinguiſh between an human *Calculus*, and a Pebble, or other ordinary Stone; and between Courſe and Fine, native *Cinnabar*: And between a true Guinea, or

or other piece of coyned Gold, that is not very ſmall, and a counterfeit One, of Braſs, or any ſuch mixture, tho' never ſo finely guilt.

And *Secondly*, Becauſe, *as* there are few Phyſical Experiments, wherein Mathematical Preciſeneſs is neceſſary, and fewer wherein 'tis to be expected; *So* in many Hydroſtatical Tryals, 'tis very probable, that the difference of Bodies of the ſame kind, or Denomination, flowing from their Compoſitions, and internal Textures, will make a diſcernable, tho' but ſmall, difference in their ſpecifick Gravity: As, in Rock-Chryſtal it ſelf, we have found ſome pieces to be to Water, as 2 $\frac{1}{10}$, or a little more, to One; and others, to be to the ſame Liquor, as Two and Six, or between Six and Seven Tenths to One. And therefore, how exact ſoever the Ballance be, there muſt be ſome Allowance made for the diverſity, that may be found in the Bodies themſelves, that are examined, which diverſity may perhaps

produce, at leaſt, as great a Difference in the Proportions we ſeek for, as needs to be expected from a ſmall Difference of tenderneſs, in the Ballances we imploy. And indeed, neither One of thoſe Differences, nor the Other, (nor perhaps Both together,) is wont to be ſo conſiderable, as to challenge much regard in Phyſical Experiments; or at leaſt, as to hinder it to be true, that, on moſt occaſions, the Hydroſtatical Way of examining the ſpecifick Weight of Bodies, is preferable by far to any other Way of doing it, that has been Practiſed.

Before I proceed to the remaining part of this Eſſay, it will be worth while to obviate an Objection, that I foreſee may be made by Critical Naturaliſts, againſt the Method hitherto deliver'd, of finding the Proportion in Weight, betwixt a ſinking Body, and Water of the ſame Bulk. For it ſpeciouſly may, and probably will, be objected, that, by this Method, we cannot diſcover the

the Proportion between a Solid Body, and Water in General; but only betwixt the propoſed Body, and the particular Water 'tis weighed in; becauſe there may be a great Diſparity between Liquors that are called, and that deſervedly, common Water. And ſome Travellers tell us from the Preſs, that the Water of an Eaſtern River, which, if I miſtake not, is *Ganges*, is by a Fifth part lighter than our Water.

But to this plauſible Objection, I have Two things to Anſwer.

And *Firſt*, having had, upon ſeveral occaſions, the Opportunity, as well as Curioſity, to examine the Weight of divers Waters, ſome of them taken up in Places very diſtant from one another; I found the difference between their ſpecifick Gravities far leſs, than almoſt any Body would expect. And if I be not much deceived by my Memory, (which I muſt have recourſe to, becauſe I have not by me the Notes I took of thoſe Tryals) the difference between

VVaters, where One would expect a notable Diſparity, was but about the Thouſandth part (and ſometimes perchance very far leſs) of the VVeight of either. Nor did I find any Difference conſiderable, in reference to our Queſtion, between the VVeight of divers VVaters of differing kinds, as Spring-water, River-water, Rain-water, and Snow-water, tho' this laſt were ſomewhat lighter, than any of the reſt. And having had the Curioſity to procure ſome VVater brought into *England*, if I much miſ-remember not, from the River *Ganges* it ſelf; I found it very little, if at all lighter, than ſome of our common VVaters.

And now I ſhall repreſent in the *Second* place, that I do not pretend, (and indeed 'tis not neceſſary) that the Proportion, obtainable by our Method, ſhould have a Mathemacal Preciſeneſs. For in Experiments where we are to deal with groſs Matter, and to imploy about it material Inſtruments; 'tis ſufficient to have

have a Physical, and almost impossible to obtain (unless sometimes by Accident) a Mathematical Exactness; as they will scarce deny, that have, as I have done, considered, and made Tryal of the Difficulties, that oppose the Attainment of such a Precisenes.

CHAP.

CHAP. XV.

Hydrostatical Stereometry, Applyed to the MATERIA MEDICA.

SECT. I.

THere is an Use of Hydrosta-ticks, which tho' it do not *directly* tend to the *Examen* of Drugs, or Simples received into the *Materia Medica*, yet may be Serviceable both to the Physician and the Naturalists, in delivering their Descriptions; and so it may *indirectly* conduce to the knowledge of them; and help, on some occasions, to distinguish between Genuine Simples (especially Fruits) and those that are not so;

'Tis

'Tis known, that the Writers of the *Materia Medica* are wont to set down the Bigness of the Bodies they describe, by very uncertain Guesses; and those that, to be more accurate, assign them determinate Measures, are wont to do it, by saying, that such a Fruit, or other Body, is, for Example, an Inch, or two Inches, or half a Foot long; and half an Inch, or a whole Inch, or two Inches and an half, in breadth. But 'tis obvious to those that are not great Strangers to the Mathematicks, that, according to this Way of describing Bodies, there may be, by reason of the great Variety of Figures, especially irregular Ones, they are capable of, a very great Disparity of Magnitude, or Bulk, in Bodies, to each of which, the same Length and Breadth may belong or be applyed.

I should here be able to present you an Hydrostatical Way of determining the Bulk of Bodies, both much nearer the Truth, than that newly

newly recited, and grounded as well on Experiments as Mathematicks; if among other Papers, I had not unfortunately loſt One, that I wrote many years ago, about *the meaſuring of Solids, by the help of Liquors.* But tho' I cannot, out of my Memory, recover the *Theoretical* part of that Writing, (whoſe Loſs I regret, becauſe it had been examined by One of the exacteſt, as well as famouſeſt, Mathematicians of our Age, whom I invited to be preſent at the chief Experiments) yet, I think, I can call to mind as much of the *Practical* Applications of it, as may ſuffice for my preſent purpoſe.

The ground of the Way, I am about to propoſe to you, will be eaſily underſtood by the following, tho' but ſhort, Account. I cauſed to be carefully made by skilful Artificers ſeveral Cubes, both of different Sizes and different Materials, as Marble and Metal; whoſe ſides were each of them, as near as the Artiſt could make them, either an exact Inch, or preciſely more Inches than

One,

One, according to our *English* measure; which is said to differ very little from the correspondent One of the old *Romans*. These Cubes were carefully weighed in trusty Ballances: First, in the Air, and then in common Water. And tho' I found some little (and but little) difference, between the Products of the Tryals; yet that Difference being no more than might reasonably be expected from the scarce avoidable Imperfection, even of good Artists and their Tools; We concluded, that One might, without any considerable Error, take a *Medium* (as they speak,) between these Products, and allow even to this *Medium*, a Latitude of some Grains; since that Latitude will not amount to the Sixtieth part of the Weight of a Cubical Inch of Water. Since therefore some of our Tryals inclin'd us to judge, that about Two hundred and sixty; and some others to think, that about Two hundred fifty two; and others again, that about Two hundred

dred fifty ſix, came neareſt to the true Weight of a Cubical Inch of Water; we thought our ſelves at liberty to make uſe of that Number, that ſhould appear moſt commodious for Practice, by reaſon of its Diviſions and Subdiviſions into *Aliquote* Parts; Eſpecially if the Body to be examined were not great; ſince, in that Caſe, Two or three Grains more or leſs would not be conſiderable, eſpecially in a Phyſical Experiment, where Geometrical exactneſs is not to be expected, nor indeed required; and a far leſs accurate Eſtimate will be leſs unaccurate, than can with any certainty be made by the formerly mentioned Way of judging, by the Length, Breadth, and Depth (or Thickneſs) of the Body propoſed.

I made the leſs Scruple to pitch upon the laſt of the Three forementioned Numbers of Grains, *not only*, becauſe it affords many *Aliquote* parts for a Number that is no greater, ſince barely by a ſucceſſive Bipartition

tion, it affords Seven ſuch Parts, *viz.* 128. 64. 32. 16. 8. 4. and 2; *But*, becauſe I was incouraged by an Experiment differing from thoſe already mentioned. For, having cauſed to be purpoſely made by a good Artiſt, an hollow Cube of Braſs, whoſe Cavity was fitted to contain a juſt Cubical Inch of Matter; (either Solid or Liquid,) we put it into one Scale of a tender Ballance, with a juſt Counterpoize in the other, and placed it there, as Horizontally as we could. Then we warily put into it, little by little, as much common Water, as it would contain, without either overflowing, or having its Surface, manifeſtly turgid; putting alſo from time to time in the oppoſite Scale, ſmall Weights to keep it from ſwerving too much at once from an *Æquilibrium*. And tho' it is extremely difficult in Practice, to diſcern with certainty, when the Veſſel is ſo exactly filled, that a Drop, or even Two, or Three drops, more or leſs, cannot be added, or taken away,

way, without being obſervable by the Eye; *Yet*, for this very Reaſon, we thought our Experiment agreeable enough to our Suppoſition, when we found, that by ſo light an Alteration, the Weight of the Water, when the Scales were heedfully Counterpoized, amounted to near about Two hundred fifty ſix Grains, which Number we ſhall therefore hereafter imploy, as expreſſing the Weight of a Cubical Inch of Water.

And now to apply the paſt Diſcourſe to our preſent Purpoſe.

Suppoſe, for Example, that a Solid, heavier *in Specie* than Water, having been weighed firſt in the Air, be found to loſe of its Weight in the Water ℥ß Sixteen Grains, that is, Two hundred fifty ſix Grains, I ſay, that the Dimenſions of this Solid, if it were of a Cubical ſhape, would make it equal to a Cubical Inch: So that, (to expreſs the thing yet more clearly,) if the given Body be ſuppoſed to be an eaſily fuſible Metal,

Metal, as Tin, or Lead; and being melted to be warily poured into the hollow Cube formerly mentioned, and suffered to cool; it would just fill it and no more; and consequently be a Cube of Metal, whose Length, Breadth and Depth are equal to one another, and each of them to an Inch. For, as 'tis a Fundamental *Theorem* in Hydrostaticks, demonstrated Mathematically by *Archimedes*, and elsewhere Physically by me; that *a sinking Solid weighs lesse in Water than in Air, by the Weight of as much Water as is equal to the Solid in Bulk*; and since we have lately shewn by Experiments, that a Cubical Inch of Water weighs ʒ*ß*. 16. Grains, that is, 256 Grains; it will follow, that when the Decrement of a Bodies weight in Water is found to be 256 Grains, the Solid content of that Body is a Cubical Inch: Since an *Aqueous* Body weighing 256 Grains is equal in Magnitude, as well to

the Solid propounded, as to a Cubick Inch of Water. And here it may prevent a Scruple, to observe, that, to make Bodies equal in Magnitude, it is not at all necessary, that they should be of the same Weight, or of the same Matter; as is evident in Bullets of Copper, Tin and Gold, cast separately and dextrously in the same Mould. For tho' they be equal in Bulk, yet the Bullet of Copper will be much heavier than that of Tin; and the Bullet of pure Gold will be more than twice as heavy, as that of Copper. Whensoever therefore you meet with a Solid, ponderous enough to sink in Water, that being weighed in that Liquor loses 256 Grains of the Weight it had in the Air; you may conclude, the Magnitude or Bulk of that Body to be equal to a Cubical Inch; of whatever Matter it consists, or of what Shape soever, regular or irregular, it be. And in case the Solid proposed do (as it will very often happen

happen) loſe of its Weight in the Water leſs than 256 Grains; you may conclude its Bulk to be proportionably leſs than a Cubical Inch. And ſuch is the Conveniency of the Number we have pitch'd upon, which abounds in *Aliquote* parts; that every 32 Grains, that the Solid loſes of its Weight in the Water, anſwers to an Eighth (that is, half a Quarter) of an Inch in the Bulk of the Body: as, if the Decrement be 128 Grains, the Solid will be half a Cubick Inch; and if it be but 64 Grains, 'twill be but a quarter of a Cubick Inch; and ſo if it be 160 Grains, 'twill be $\frac{5}{8}$, that is, half and half a quarter of an Inch Cube: and on the other ſide, if the Decrement of the given Body exceed the Standard, *viz.* 256 Grains, twice, thrice, &c. then that Decrement being reduced to Grains, as ſuppoſe it weigh ℥i + Grains 32 (amounting to 512 Grains;) or ℥i ſß + Grains 48 (amounting to 768 Grains) the Body will be equal

to two or three (single) Cubical Inches. And if, after the Division there remains a Fraction, 'twill not be difficult to estimate it, to him that considers what has been newly delivered.

SECT. II.

TO discover Hydrostatically the Solid Contents of a Body heavier *in Specie than Water*; to him that knows how to make use of the Method newly delivered, 'twill not not be very difficult. But to measure, by the help of Water, the Solidity of a Body lighter *in Specie*, than that Liquor; is a work not so easily performed. It may somewhat lessen the Difficulty, to premise, that there are two sorts of Bodies, that will naturally not sink in Water. For *some* are of a closer Texture, and will

will not be easily invaded by that Liquor; at least, in so short a time, as they are of necessity to be kept in it: and *others* abound with Pores, that dispose them to imbibe the Water, they must be kept immersed in, till the Experiment be dispatched.

To begin with the First sort of Bodies: 'Tis known to Hydrostaticians, that, according to a *Theorem* of *Archimedes*, the weight of a Body belonging to that kind, may be gathered from the weight of the Water, that is equal, in Magnitude, to that part of the Body, that is immerst in that Liquor, when the Solid floats freely upon it; as, if a *Paralelipipedon*, or a *Cylinder*, of Wood, 12 Inches long, being placed upon Water, should rest there, when a 12th part of it lyes beneath the Surface of the Liquor; in this case, the Weight of the Water, equal in Bulk to that immerst 12th part, would be equal to the weight of the whole wooden Body. But because the Bodies, whose Bulk Physicians and Chymists may have occa-

sion to Examine, will very seldom happen to have Shapes so near those of regular Ones; 'twill scarce be worth our while to inlarge upon this Way of Estimating light Bodies; which 'twill be so troublesome to make fit for most Mens Practice, that, unless it be desired, I shall not trouble you with it; but forthwith proceed to what will conduce far more to our present Design, which being, *To measure the Solid Contents of Bodies, not so heavy (intensively) as Water, and for the most part irregularly shap'd*; It will be necessary, that we imploy a Method differing from what we have hitherto made use of. In the First step of this, tho' not in the Second, we may be helped by the industrious *Mersennus*: Who probably borrowed his Way of *Ghetaldus*, from whose *Promotus Archimedes*, he professedly borrows many things.

But because, that, on this occasion, *Mersennus*, affecting Brevity, hath made himself obscure; so that what he

he writes can ſcarce be underſtood, but by Mathematical Peruſers; I ſhall, for the ſake of another ſort of Readers, deliver the propounded Method, tho' not in ſo few words, yet more clearly, and orderly: *Firſt* then, you ſhall weigh in the Air, the Body, (lighter than Water) to be examined: *Secondly*, you ſhall take a Plate of Lead capable of making this Body ſink with its ſelf in Water, and of ſome Weight not incumbred with Fractions, as juſt a Dram, half an Ounce, an Ounce, &c. *Thirdly*, you muſt weigh this Plate in Water, and by ſubſtracting its Weight in this Liquor, from what it weigh'd in the Air, you muſt obtain a Difference, which will give the weight of as much Water, as is equal in Bulk to the immerſed Lead. This, for diſtinctions ſake, may be called, *The ſpecifick Weight of the Lead in Water*. *Fourthly*, you muſt tye together (which you may beſt do by One or more Horſe-hairs,) the Plate of Lead, and the lighter Body, and

note the Weight of the Aggregate; which, as you know, is nothing but the Sum of the reſpective Weights of the lighter, and of the heavier, Body. *Fifthly*, you muſt weigh this Aggregate in the Water, and ſubſtract its Weight in that Liquor, from the Weight that the ſame Aggregate had in the Air; and the Difference will be the Specifick Weight of the ſaid Aggregate in Water. *Sixthly*, From this Difference, ſubſtract *the* formerly found *Specifick Weight of the Plate alone in Water*, and the Remains will give you the Weight of the lighter Body in the ſame Liquor.

Thus far our Author; without whoſe help, we may eaſily diſpatch the reſt of our Work, by the Method imployed already of meaſuring Solids heavier than Water. For the lately obtained Weight of the light Body in Water, being, (according to the Method formerly propoſed,) divided by 256 Grains, will give you the Solid content of that naturally floating Body. But

But becauſe a Method, that is difficult enough to be put in Practice by thoſe that are not more than ordinarily well verſed in Hydroſtaticks, requires to be illuſtrated by an Example; I ſhall ſubjoyn an Experiment, that may ſerve, not only to clear up this Practice, but, in good meaſure, to confirm it too; We took then a piece of Oak conveniently ſhaped, and that weigh'd in Air, 193½ Grains. To this we tyed with an Horſe-hair, a Plate of Lead weighing juſt half an Ounce, *i. e.* 240 Grains. But before we tyed them together, the Lead was weighed in Water, where it loſt of its former Weight 20 Grains, which, being deducted out of the 240 Grains lately mentioned, left a Difference or reſidue of 20 Grains, for the Specifick Weight of this piece of Lead, (For I have ſeldom found Lead quite ſo heavy) in the Water. Then the Aggregate of the Wood and Lead was weighed: Firſt, in the Air, and found to be 433 Grains and an half, and Then in Water,

Water, where it amounted but to 162 Grains; which being substracted from the Aggregate of the same Bodies in the Air, the Residue, or Difference, was found to be 271 and ½ Grains: From which Difference, the other Difference of 20 Grains (which had been lately found) of the Leaden Plate alone in the Water, being deducted; there remained 251 Grains and ½ for the Weight of Water equal in Bulk to the given piece of Wood. If thisnumber had amounted to 256 Grains, of which it fell shortbut 4½ Grains, we might have concluded the Solidity of it to be a Cubick Inch; since 256 Grains of Water, which we formerly found equal to a Bulk of Water of a Cubick Inch, was also now found equal to the Bulk of the given piece of Wood. And indeed, intending (as I formerly intimated) to give an Example, that should not only Illustrate, but Confirm, the proposed Practice; I caused the Wood I imployed to be formed into as exact a Cube of an Inch

Inch every way, as I could procure from a Joyner, that bragged of the Pains he had taken about it: So that the Difference of its Weight in Water from 256 Grains, the Weight of a full Cubick Inch of that Liquor, may probably be imputed to some little Imperfection in the Figure of the Wood, or some other light Circumstance, not considerable enough to be much regarded.

Of this Experiment one of my Notes gives the following Account.

I. The Oaken Cube in Air weighs (℥iii Grains xiii ½.)	193½.
II. The Weight of the Lead in Air, (℥iv.)	240.
III. The Weight of the Lead in Water (℥iiiß Grains x.) which, being subtracted from its Weight in Air, leaves for its Specifick Weight in Water	220. 020.
IV. The Aggregate of the Two in Air is	433½.

V. The

V. The weight of both together in Water, is —— 162.
Which being ſubſtracted from its Weight in Air, gives the Difference of both the Aggregates, 271½.

VI. The Difference between the weight of Lead alone in Air, and in Water, or which is all one, the Specifick weight of the Plate alone, *viz.* being ſubſtracted from the Difference of the weights of the Aggregates in Air, and in Water, gives [for the weight of the Cube propos'd,] 020. 251½.

The Way of meaſuring Bodies, that has been hitherto delivered, is appropriated to ſuch, as will not at all, or, at leaſt, will not readily, be diſſolved in Water. But becauſe there are divers other Solids, as Lumps of *Salt*, *Alume*, *Vitriol*, *Sugar*, &c. whoſe Magnitudes it may be fit for inquiſitive Men, of more Profeſſions than One, to know, and to compare; I ſhall to what has been already

already ſaid, ſubjoyn this Advertiſement; That the ſame Way may be applyed to meaſure the Magnitudes of Solids diſſoluble in Water, if, inſtead of this Liquor, we ſubſtitute Oil of Turpentine; whoſe Proportion, and Specifick Gravity to Water, we have found, or is otherwiſe known to us. When I firſt made this Reflection, I had not ſuch Conveniencies, as when I found the weight of a Cubick Inch of Water, to determine the weight of a Cubick Inch of Oil of Turpentine. But, having yet lying by me the hollow Veſſel of Braſs, whoſe Cavity was an exact Inch, that I imploy'd to find out the weight of a Cubick Inch of Water; I made uſe of it on this occaſion too: and found that, when it was carefully filled with ſuch Oil of Turpentine, as we were wont to imploy about Hydroſtatical Experiments; the contained Liquor amounted but to 221 Grains, and an Eighth (part of a Grain;) by which number the Difference of the weight of

of a Solid in the Air, and in that Oil, being divided, the Quotient will give you the Solid Contents of the examined Body.

After so circumstantial an Account, as we have given, of the Way of Hydrostatically examining such floating Solids, as, like the Wood we imploy'd, are of a Texture at least *moderately close*; it may be seasonable, to proceed to the mention of the Second sort of floating Bodies, that I formerly told you, might be proposed to be weigh'd in Water: Namely, such as, by their Porosity or *Laxeness of Texture*, are subject to imbibe too much of that Liquor; even in as little time as is necessary for the dispatch of the Experiment.

In his Phænomena Hydraulica, *pag.* 185.

Mersennus (more briefly than clearly) proposes an Expedient in this case, which is to cover over the Body to be weigh'd in Water with Wax, Pitch, or some other Gluten, as he calls it, whose Specifick Weight in Water must be first known. But,

I

I take Bees-wax to be much preferable to the other Two. For Pitch is so apt to stick to Ones Hands or Cloathes, that 'tis troublesome to apply it, and very difficult to get it off: And as for Glues, most of them, especially the more common, are dissoluble in Water, and therefore not so fit for the purpose as Bees-wax, (for That, I presume, he means by Wax;) which has this Conveniency in it, that its Proportion to Water being usually constant enough, and the Gravity of those two Bodies differing but little, one may more easily dispatch a good part of the Experiment; which is thus to be performed. Take the Solid lighter than Water, that you would examine Hydrostatically, and having weigh'd it in the Air, over-lay it carefully with a thin Coat of Bees-wax, so that no part of it may remain uncovered, or accessible to the Liquor. Then take also in the Air the Weight of the Wax you have imploy'd, and fasten to the Body

thus

thus coated, a Plate of Lead, or Tin, heavy enough to make it ſink, and obſerve the weight of the Aggregate in Water. This done, ſubſtract the weight of as much Water, as is equal in Bulk to the Wax, and proceed with the reſt, as is before taught. *Merſennus* declares this Practice by this Inſtance, if the Wax that inveſts the propoſed Body be of ℥xxij in the Air, the Bulk of Water equal to it will be ℥xxi; and therefore a Quantity of Water of ℥xxi, muſt be firſt taken away, or ſubſtracted, that the remaining Bulk, equal to the (immerſt) Body, may, by its Gravity, ſhew the Gravity of the Body (propoſed,) as has before been ſaid.

But, becauſe the Way, above delivered, can help us but to the knowledge of the *Weight* of the propoſed Body in Water; we muſt, to diſcover the *Solid Content* of it, proceed further than our *Merſennus* enables us to goe; and therefore we muſt divide the Weight of the Solid in Water, already found, by 256 Grains,

Grains, that by the help of the Quotient we may obtain the Solid Contents of the propoſed Body.

I have ſometimes (to add That upon the By,) thought of, and try'd, another Expedient, to hinder ſmaller Solids, whether lighter or heavier *in Specie* than Water, from imbibing the Ambient Liquor. In order to this, I *firſt* found the Weight of a Cubick Inch of Quickſilver, (which is not difficult to diſcover by its Proportion to Water of the ſame Bulk.) And *then* we brought the Body to be meaſured, into a Veſſel, whoſe Solid Contents were known before; and *Thirdly*, all that was not poſſeſſed by the firm Body, being filled with Quickſilver, 'twas eaſie enough to know by the Difference in Weight of That Quickſilver, from the Weight of the Quickſilver, requiſite to fill the whole Veſſel, to how much Quickſilver the environ'd Body was equal. And by this means, and the knowledge before gained of the Weight of a Cubical Inch of

Mercury, the Solid Contents of the Body proposed was not difficult to be obtained. But I forbear to give more than this Intimation of an Expedient, which, besides that it belongs properly to another Essay, is rather Mechanical than Hydrostatical. And for the same reason, I forbear to set down one Way of measuring the Contents of Irregular Solids, delivered in some Books of Practical Geometry; and another, but yet unpublished, Way, differing enough from the Former, that tends to the same purpose.

CHAP. XVI.

But, I perceive, that 'tis now more than time, that I should put an end to a Labour, that has, I fear, tyr'd you, because, I am sure, it has tyr'd me. And yet I dare not conclude this Tract without briefly answering a couple of Questions,

Questions, that, I foresee, may justly enough be asked me by a Peruser of the foregoing Essay.

And *first*, I presume it may be demanded, *Whether I have proposed the best Ways that can be thought of, to examine Bodies Hydrostatically?* To which Question I answer, that, upon divers Considerations, some of which have been mentioned here and there in the Body of the foregoing Essay, I did not think my self obliged solicitously to Invent, or propound, new Instruments for the Hydrostatical *Examen* of Bodies. For *tho'* I am not Ignorant, that divers more curious and Artificial ways of finding out their Weight in Water, or their Solid Contents by it, may be devised by Persons more skilful and sagacious than I. And *tho'* also I think it not unlikely, that, when the Utility of such Practices comes to be taken notice of, Artificial Instruments will be found out to Facilitate, or otherwise Improve them: *Yet*, I thought it became me at first *to* propound

only the more simple Ways of Operating, as the most likely to invite the Generality of those, for whose sake this Essay is made publick; and *to* require, for the main part of our Experiments, only the Use of the Ballance, as an Instrument easily procurable, and already, for other purposes, in most Mens hands, without mentioning, at this time, any more Artificial Instruments; tho' some of them are such, as I have long since not only had thoughts of, but, for my own Uses, practised; which Intimation may be countenanced, if it were needful, by the mention of that little Instrument, for distinguishing between true and counterfeit Guineas, or the like Pieces of coyn'd Gold, by the help of Water; which was several Years ago published in the Philosophical Transactions, and has since (without staying for my Improvements of it) been made Use of by Some, and usurp'd by Others. But of such things, no more in this place.

Having

Having answered the First Question, it remains, that I consider the Second, wherein tho' I shall aim at Brevity as much, as in the former, yet I fear, I shall not be able to discuss it in as few Lines, as I did That. I presume then, it will be asked, *What Credit may be given to the Estimates of the Weight, and Proportions of Bodies, obtained by Hydrostatical Tryals?* Since, we see, that *tho'* Mathematicians, not knowing, or not applying, our Observation about the Specifick Gravity of Rock-Chrystal, and the Nature of Oil, especially that of Turpentine, have given us but the Proportions of Metals, and some very few other Familiar Bodies, as the Loadstone, Wax, Hony, Oil and Wine; *yet* those few that have not transcrib'd from one another, differ in the Tables, they have left us, of the Comparative weight of those few Bodies.

This Question is so comprehensive, that, I think, it cannot well re-

ceive a ſingle Anſwer; and therefore, I ſhall offer Two things to be conſidered about it.

And *firſt*, I freely acknowledge, that there is no exact Uniformity in the Obſervations delivered about the weight of Metals, and the other Bodies newly nam'd, among the few Authors that have written of this Subject; and there would probably have been yet more Difference in their Accounts, if ſome, even of thoſe Writers, had not avowedly made uſe, to their purpoſes, of as much as they thought fit of the Tables of *Ghetaldus*.

Nay, I ſhall not think it very ſtrange, if I find, that the Experiments of the ſame Man, made at diſtant times, and in other differing Circumſtances, ſhould not all of them exactly agree. For I have already noted, and, I think, in more places than One, that there will ſcarce be found ſo great an Uniformity in Qualities, and particularly in Specifick weight, among Bodies of the ſame

ſame Kind or Denomination, as there is generally preſum'd to be. There may be alſo ſome Difference, tho' but little, betwixt the Waters Men employ, eſpecially if the Air be at One time (as in *July*) intenſely hot, and at Another (as in *January*) exceeding Cold. The Difference alſo of Degrees of Goodneſs of the Ballances, Men employ about nice Experiments, is not altogether inconſiderable. But there is a thing of greater Moment than this, towards the hindering Hydroſtatical Experiments, and even Statical Ones themſelves, from being ſo accurate, as thoſe, that are not verſed in ſuch Matters, may require. The thing I mean, is, the Difficulty of finding an exact Uniformity in Weights of the ſame Denomination, which, for that Reaſon, are vulgarly ſuppoſed to be exactly equal; But, to know how far this Suppoſition is to be rely'd on, it may at preſent ſuffice to ſet down ſome Paſſages of a Mathematician juſtly famous for his dili-

gence, and who has made it his particular Work to examine these Matters scrupulously. The first Passage, I shall allege out of his Writings, shall be the short Account he gives of many Tryals he made of natural Grains, whence all sorts of weights have been deduced. *Cùm* (saith he) *omnia grana, vel semina, quæ reperiri solent in atriis venalibus Lutetiæ, ad Stateram expendissem, vixque granum ullum inter ejusdem speciei grana grano alteri exactè respondisset, in incertis ludere nolui.* The same Author informs us, that the *Roman* Grains differ from the *French* Grains; since, as, he observes, 688 Grains of the former sort, are Equiponderant but to 576 Grains of the later sort. And he subjoyns, that, whilst he was writing these things, there was found by the more exact weights of the Mint, an Error in the former Estimate, of at least half a Grain in 36 Grains.

In Præfatione ad Librum de Mensuris, ponderibus & nummis.

And elsewhere he gives notice, that, by two Relations, sent him from *Rome*,

Rome, about the Number of Grains, contained in a *Roman* Ounce, it appear'd, that even that Number varied, since One of those Relations reckoned 612 Grains in an Ounce, whereas the other allowed it but 576 Grains. And yet this I do not wonder at, because I have my self found it so difficult in Practice, to *get* and *keep* Weights (for, as little as this is wont to be suspected, the the very Air may, in time, a little alter them,) as exact, as I desired, that I left off the hopes of it. And one Remark, tho' commonly overlooked, I think too considerable to be here omitted. For, whereas the accurate *Ghetaldus*'s Tables of the Weight of Metals, and some few other Bodies, in reference to one another, are looked upon as the most Authentick that have been published & are accordingly made the most use of: 'Tis certain, that the Weights he employ'd are not divided, as Ours are. For, tho' indeed according to him,

Mersennus *in the Paper entituled*, Parisiensia Pondera, *Corollar.* 1. *and* 2.

In the Paper called Galic. Nummis.

as

as well as with us, the Ounce consists of Four and twenty Scruples; yet the Scruple, which with us is divided but into 20 Grains, he divides into 24. But to return to *Mersennus*, a while after he had told us of the Difference between his repeated Tryals, and Those of other Men, in determining the Weight of a certain Body, he has this Passage; which shews, that he was not over-confident of the Preciseness of all his own Determinations. *Cum autem* (saith he) *pag.* 37. *lib.* 16. *Dixi, Chelinum, undecim dici denariorum, credunt tamen alii decem duntaxat, nil asserо.*

Having gone thorough the First part of my Answer, to the Second Query above proposed, it remains, that I proceed to the Other part; which perhaps will not need more than the following Reflection.

I consider then, that *tho'* it be granted, that Hydrostatical Experiments are not always either singly accurate, or exactly agreeable among them-

themſelves; *yet* they may well be, *both* accurate enough to be of very good Uſe, eſpecially in Practice; *and* leſs remote from being quite accurate, than any other Ways that have been hitherto known to be Practiſed, of determining the Proportions of Bodies in point of Weight and Bulk, and of meaſuring the Solid Contents of ſtable Bodies, whether heavier *in Specie* than Water, or lighter.

The *Firſt* part of this Reflection may be deduced, as a Corollary *from*, or at leaſt confirmed *by*, the greateſt part of the foregoing Eſſay. And indeed, as little Skill as I have in Hydroſtaticks, I would not be debarred from the Uſe of them, for a conſiderable Sum of Money; it having already done me acceptable Service, and on far more occaſions, than I my ſelf at firſt expected; eſpecially in the *Examen* of Metals and Mineral Bodies, and of ſeveral Chymical Productions. And I have been able

more

more than once or twice, to undeceive Artists and other Experimenters, that, *bona fide*, believed they had made, or were Possessors of, *Luna fixa*, (as they call it) and other valuable things: And to make a good Judgment of the Genuineness or Falsity, and the Degrees of Worth, or Strength, in their kind, of divers richer or poorer Metalline Mixtures, and other Bodies, (some Solid, and some Liquid,) whose fair Appearances might otherwise have much puzzled, if not deceived, me.

But of This more may be found in another Paper. For I must hasten to the *Second* part of our designed Reflection, by representing, That our Hydrostatical Methods of discovering the Weights and Bulks of Bodies, tho' they be not Mathematically accurate, yet they are less remote from being so, than any Way of Mensuration of Bodies, (especially such little Ones, as we usually have need to examine on the account

count of the *Materia Medica*,) by the Geometrical Instruments, that are hitherto known to be Practised; or, by the Way, whereby the *Tabula Coitionis & Expansionis Materiæ per Spatia in Tangibilibus, &c.* was framed by the renowned Sir *Francis Bacon*; whose judicious Reflections upon the Rarity and Density of Bodies, such as their measures are delivered in that Table, do sufficiently manifest, as the Philosophical *Genius* of the Author, so the Utility that may be derived from even such Determinations of the Bulks and Weights of Bodies, as fall short enough of being accurate.

Verulam in Historiâ densi & rari, p. m. 8. &c.

I might here relate, that, to convince some curious Persons, how much Hydrostaticks may be made serviceable to as accurate Mensurations, as ought to be expected in Physical Experiments; I desired a *Virtuoso*, First, to put together two Lumps of Metal (*viz.* of Tin, and of Lead) in a certain Proportion, that

that he was to conceal from me, but to set down in Writing to prevent Mistakes. Then I desired him to melt the Metals (whose respective Specifick Gravities I knew before) into one Mass, and give me that Mass. And Thirdly, I weigh'd it carefully in Water; and did also Algebraically examine it. Which being done, I told him, that the Lead, he had imploy'd, amounted to such a Weight, and the Tin to such another; which being compared with the Quantities he had committed to Paper, the Difference was found to be little more than one Grain, and this it self probably proceeded from some scarce avoidable Imperfection in the melting, pouring out, &c. of the given Bodies. But because specious Arithmetick was employ'd in this Work, (to which, yet it was not absolutely necessary,) I shall lay no Stress upon it; because, if I mistake not, the past Discourse may suffice to give the Hydrostatical Ways, of Mensuration

ſuration of Bodies, a preference to their Competitors; and may keep it from being preſumptuous, to ſay, that they may be received as the beſt for Practice, till ſome other more accurate, and yet as firmly grounded, and as Practicable, Ways of accompliſhing the ſame purpoſes, ſhall be propos'd.

FINIS.

A Previous

Hydroſtatical Way

OF

Eſtimating ORES.

A Previous

Hydrostatical Way

OF

Estimating ORES.

Advertiſements.

I *Know there is a greater Number of different kinds of Foſſiles, than Thoſe that are yet known to belong to the* Materia Medica. *And, I confeſs, that the Perſons, which the following Paper is chiefly deſigned to aſſiſt, are thoſe that explore Minerals with an Aim not at* Health, *but at* Profit. *But yet I was content, that the enſuing Diſcourſe ſhould accompany the foregoing Eſſay, as a kind of Appendix to it, becauſe many of the Subjects, about which both Tracts are converſant, are the ſame; and the Fundamental Obſervation,* (viz. *about the Specifick Gravity of Chryſtal or Marble,*) *and the Hydroſtatical Way of applying it, in Explorations, is the ſame*

in both: and also, (and indeed, chiefly,) because I was made to believe, that it might, especially at this Season, be grateful, and not unuseful, to divers Searchers after profitable Minerals.

This Paper (as the Inscription intimates,) was designed to be sent to the Learned Secretary of the Royal Society; when it was expected, that he would begin again to publish Monthly the Philosophical Transactions, that had been long suspended, and as long desired by the Curious. But since some Accidents have occurr'd, that occasion a further delay of their Publication, it was not thought fit, this Paper (after having been long already) should be any longer confin'd to my Closet. 'Tis true, that this Discourse, containing but an Application of an Hydrostatical Experiment; I am far, as I ought to be, from proposing it as a Treatise of the Docimastical Art; whose grand Instrument is, the Fire Skilfully manag'd. For which reason I have forborn to set down in this Paper,

Paper, any of the Flux Powders, or other Ways of Examining Ores; or of Reducing Them, or other Foſſiles, to Metals or Regulus's; *that either Say-Maſters are wont to employ, or I have deviſed, or try'd, upon Minerals. But, this notwithſtanding, our unpractiſed Way of Eſtimating Ores, may not be uſeleſs; and for that reaſon, will not perhaps be unwelcome to ſome, that Love Mineralogy, much better than they Underſtand it: Eſpecially coming forth at a time, when many induſtrious Perſons of this Nation are excited to look after profitable Minerals, by the Repeal (that has been made, ſince our* Appendix *was written,) of a diſcouraging Act of Parliament, made in the Reign of* Henry *the* IV. *And tho' our Hydroſtatical Way, of Eſtimating Foſſiles, will not determine how Rich or Poor they are in this or that particular Metal; yet, (as is intimated at the beginning in the enſuing* Paper,) *it may, on many occaſions, ſerve to keep*

those that are Venturous, and not Skilful, from being deluded by Cheats, or from deluding themselves with ill-grounded Expectations; which the Promising appearances of divers Fossiles, especially Marchasites, will temptingly Invite, but never Answer.

A Previous Hydrostatical Way OF Estimating ORES.

Addrest to the Secretary of the R. S.

SECT. I.

Sir,

AT a time, wherein so many ingenious, or industrious, Men appear very Solicitous to discover and to work Mines, both Here and in *New England*, and Others of his Majesties *American* Colonies; it will not, probably, be thought unseasonable, nor prove unwelcome

A Way propos'd for the previous Examen of Ores.

come to the Seekers of Subterraneal Treasures, if my desire to do them a piece of Service, make me borrow of a Paper, I long since wrote about some things relating to the *Materia Medica*, a few Paragraphs, that contain a Way of Exploration of Minerals; which tho' it reaches but to One of their Qualities, will, perhaps, by reason of the Considerableness of of This, keep, on certain Occasions, some Searchers after Mines from beginning chargeable Works, or prosecuting them with too great Expectations, which are usually follow'd by proportionable Disappointments. And I make the less Scruple to suffer this Fragment to leave its Company, and present it self to you; because, after the misfortune, I have formerly signified to you, of the Loss and Spoiling of several of my Writings, I know not when, if ever, I may have Opportunity of Communicating to my Friends the Treatise, that these Paragraphs belong to.

That

That Part of the forementioned Treatiſe, that concerns my preſent purpoſe, is founded on an Experiment, whereof what you are about to read, is One of the Applications.

I ſhall then ſuccinctly inform you, that the Obſervation, whereon my Diſcourſe was grounded, is double, as will by and by appear; and that the Riſe of it, which will help to underſtand the Nature and Influences of it, was this. I thought fit, (for Reaſons elſewhere given) to find out, what was the Specifick Gravity of a pure Stone, ſuch as I ſuppoſed Chryſtal or White Marble, or a Stony Iſicle, to be; and found it by the Hydroſtatical Way of Tryal, (doubtleſs not unknown to You,) that is delivered in the Eſſay called *Medicina Hydroſtatica*, whereof when you pleaſe, you may command a ſight, to have to clear common Water, equal to it in Bulk, or Magnitude, pretty near the *Ratio*, or Proportion of two and an half to one; or, which is ſomewhat more

obvious

obvious to conceive, as five to two. I ſaid, *pretty near*, becauſe 'tis not always exact, nor need be for our preſent purpoſe, but uſually enough does ſomewhat rather exceed that Proportion than fall ſhort of it; but that is ſo little, that it may, on all common Occaſions, be ſafely enough neglected by a Mineraliſt: Tho', if one pleaſes, one may make uſe of the Proportion of 2 ¾ to 1, that is, of 11 to 4.

SECT. II.

THe Uſes, that may be made to our preſent purpoſe of this Fundamental Obſervation, are either of a more General, or of a more Particular, Nature.

As to the firſt of theſe; *When* my Intention is only to diſcover in general, Whether a Foſſile propounded, or perhaps caſually lighted on, may with probability be judged to contain

contain any Subſtance, either Metalline, or belonging to ſome Foſſile of Affinity to a Metalline Nature; and alſo, Whether, in caſe the firſt Queſtion be reſolv'd in the Affirmative, the propoſed Body does, indefinitely ſpeaking, contain much, or but little, of the Metalline or other Adventitious Subſtance: *When*, I ſay, I would only make thoſe General Inquiries, I weigh the Body I would examine, firſt in Air, and then in Water, and obſerve the Proportion in Specifick Gravity between them; and if I find it weigh either leſs, or but *little* more, than Chryſtal or Marble of the ſame Bulk, I judge it unlikely to contain any Metalline Portion, conſiderable for its Quantity. And if it weigh manifeſtly, or ſomewhat *conſiderably*, more than Marble or Chryſtal, I gueſs, that, in Proportion to that Exceſs, it abounds, more or leſs, with a Metalline Ingredient, or one or other of Affinity to a Metalline Nature.

To

To explain my self a little by two or three Examples; 'tis known, that the *Magnet* is vulgarly reckon'd amongst *Stones*, and its great Hardness confirms Men in that Opinion. But having observed, that Loadstones, especially those that come from some Places, that I elsewhere take notice of, seem to be *apparently* more ponderous than common *Stones* of the like Bulk; We weigh'd them in Air and Water, and found their Specifick Gravity, especially of some of them, so far to exceed That of Chrystal or Marble, that it could not be difficult for us to conclude, that these Fossiles contained a not inconsiderable Proportion of Metalline Matter, which, by Collateral Experiments, delivered in another Paper, appear'd to be of a Martial or Ferruginous Nature.

The Author means a Paper containing Experiments and Observations about the Loadstone, as 'tis a Mineral.

Emeri is a Fossile well known to many Tradesmen, especially *Armourers*, & *Gunsmiths*, by whom 'tis commonly reputed a mere Stone. But finding that its Weight in Water consider-

rably

rably exceeded That of Chryſtal of the ſame Bulk, ſince it was to that Liquor very near, as 4 to 1; I conjectured, that it contained a Metalline Subſtance, as afterward, by proper Tryals, I found it to do. Upon the ſame ground, (its Weight in my hand) I concluded, that *Lapis Hæmatites*, that is commonly ſold in Shops, and, as its Name witneſſeth, paſſes for a Stone, did not ſparingly participate of a Metalline Ingredient; in proſecution of which Conjecture, I quickly thought on Ways whereby I diſcovered, that Iron or Steel was the Metal it contained.

And not to accumulate Inſtances in this place, I ſhall advertiſe you in general, (what perhaps may hereafter be found uſeful to ſeveral Enquirers) that, upon the Grounds hitherto mentioned, I was invited to gueſs, that divers Bodies, that were little ſuſpected to be of a Metalline, or Mineral, Nature, did really contain a Portion of Subſtance that was ſo. And, I remember, in particular, that,

that, having met with *Granats* of several sizes, that were not *Bohemian*, but were found in other Parts of *Europe*, and some that I discovered in a kind of *Talc*, that was brought me from *America*; which Angularly figured Stones, I suspected by their Weight to be Metallick, and found, by Hydrostaticks, to have a Specifick Gravity considerably surpassing That of Chrystal. Upon these Grounds, I say, I suppos'd them to participate, and that not very sparingly, of a Metal, one or more; and, by other Ways of exploring, found, that I had guessed aright; since I was able, notwithstanding the great Compactness of such seemingly vitreous Bodies, to discover there a Decomposition, and extract thence a Metallick Substance.

To these I might add other Fossiles, and some that were not, even by Men not unskilful, suspected to have any Metalline Ingredients. But I have not time to speak of Them,

Them, and therefore shall proceed in the lately begun Discourse.

SECT. III.

TO illustrate then the general Observation, formerly laid down, and make it more distinct, I shall subjoyn the following Remarks.

First, I do not pretend, by this Way, to make any more than probable Conjectures and Estimates, about the Contents of the Bodies, I examine by it: But tho' the Estimates, grounded on it, be not always True, yet they may be frequently Useful, as may be gathered from some of the subsequent Observations.

Secondly, If the Fossile proposed be lighter, especially if it be much lighter, than so much Chrystal, it is an almost certain Token, that it is not

not a Metalline Ore. And this Negative use, if I may so call it, of our *Hydrostaticks*, may be more safely relyed on, than the Affirmative Consequences usually can be. Thus, when I find that *Jet*, tho' a Fossile dug up in Veins, especially in the *Pyrenean Mountains*, (as a Learned Man, whose Brother has there a Mine of *Jet*, assured me) has far less of Specifick Gravity, than Chrystal, I conclude it to be no Metalline Body. The like Inference I make, on the same ground, as to Fossile Amber or *Succinum*, *Sulphur vive*, and the Observation holds in common *Sulphur*, (clear or *Semidiaphanous*) English *Talc*, Venetian *Talc*, and some other firm Concretions, whether Brittle or not, that are dug out of the Earth. Among these, I think fit to mention particularly Black-Lead, lest the Name it bears, should deceive Men into a Belief, that 'tis an Ore of that Metal. For having found its Weight, in reference to Water, to be but as 1 $\frac{85}{100}$ to 1. And, gathering

ing from the Smalneſs of its Specifick Gravity, that it would prove to be very unlike our true common Lead Ores, I found, upon Tryal purpoſely made, that, 'twas a Mineral *ſui generis*, and ſeemed, upon the ſcore of more than one Quality, to be of kin to a ſort of *Talc*, that I have met with.

Thirdly, We ſhould diſtinguiſh between the ſeveral Uſes, that Foſſiles may be ſought for, and examined, by Men of different Profeſſions, or Deſigns. And therefore, if a Foſſile be found to be ſomewhat, and yet but very little, heavier in *Specie*, than Chryſtal or Marble; it may poſſibly have a Metalline or Mineral Portion, which, tho' very ſmall in quantity, may conſiſt of ſuch Efficacious parts, as may make it deſerve the Eſteem of a Jeweller, a Phyſician, or a Chymiſt. But if the Surplus of Specifick Gravity be inconſiderable, the Foſſile it ſelf will be ſo too to a Mineraliſt, that ſeeks not to gratifie his Curioſity, or make a

good Medicine, but to fill his Purſe. For the Charge and Trouble of working a Foſſile, ſo poor in Metalline Subſtance, will probably either exceed the Profit, or keep it from being conſiderable; whereas, if the Specifick Gravity do much exceed That of Marble or Chryſtal, it may give good hopes of proving a Subject profitable to be wrought on.

Fourthly, But, here I muſt give notice, that, *tho'* for the moſt part, the great Ponderoſity of a Foſſile proceeds from a Portion of ſome Metalline Subſtance, more ſtrictly ſo called, that is imbody'd with the other part of the Concrete; *yet* this alone is indeed a certain Sign, that the Foſſile is not a mere *Stone*, but is not alone a ſure Sign, that the Mineral Portion is properly *Metalline*; and therefore, where there is juſt Cauſe of doubt, 'tis beſt to endeavour by ſome Collateral Signs to reſolve it. The Reaſon, why I thought fit to give you this Admonition, is, that, beſides *Metalline Ores* more properly

perly so called, there are other Fossiles, which some call *Semi-Metals*, others *Media Mineralia*, and others again give other Appellations to; which Fossiles, tho' of Affinity to Metals, are wont to be distinguished from true Metalline Ores; such (Fossiles) as are (that I may here name the principal of them) *Antimony*, *Bismuth*, (usually in our Shops called *Tin-glass*) *Lapis Calaminaris*, and *Pyrites*, commonly called *Marcasites*, and vulgarly, in English, *Vitriol Stones*.) But there will not perhaps occur many Cases, wherein it will be necessary to have recourse to Collateral Signs, to discern, Whether the Mineral Portion of a Fossile, be, in a stricter Sense, of a Metalline Nature, or not: For these *Semi-Metals* that I speak of, are most commonly found either in Veins, or in Masses, or great Lumps of their respective Kinds; and easily discover, to one that considers them with so much as a moderate measure of Attention and Skill, what *Species* of Fossiles they belong to. I have in-

deed from *Devonshire* received a Lump of Matter, which the Owne of the Mine, not knowing what t make of, desired my Opinion of wherein I found some *Antimony* mix with Lead, which was the Predomi nant Body. But such Mixtures oc cur not often enough, at least her in *England*, to keep our Way o Estimating ponderous Fossiles fron being, on most occasions, useful.

SECT. IV.

Fifthly, 'Twill be almost necessa ry to give you notice in thi place, that there may be a two-fol Estimate made of the Specifick Gra vity of Ores; *One*, when the Metal line Body proposed is weigh'd in it natural State, that is, as 'tis take out of the Earth, accompanied witl the Sparr, or other Heterogeneou matter, that firmly adheres to it (only the loose Earth being first wa shed off:) and the *Other*, after it ha been

been beaten ſmall and ſeparated from ſtony, and other Heterogeneous, Subſtances, by the help of Water; where being skilfully agitated, there is eaſily diſcovered a notable Diſparity in Weight between theſe, and the Genuine, or Metalline, parts of the Ore, which being thus ſever'd from the reſt, are called, for inſtance, waſhed Tin, if afforded by a Vein of that Metal. And ſometimes alſo 'tis very Uſeful, if not Neceſſary, to prepare the Ore by roſting it, (as they ſpeak) once, or oftner, or by keeping it ſeveral hours in a competently ſtrong Fire, as is uſually enough done to prepare Copper-Ore, eſpecially if it be ſtubborn. I have diſtinctly mentioned theſe Two States, wherein the Weight of an Ore may be eſtimated; becauſe, I have obſerved, that in ſeveral Caſes 'twill much import the Experimenter to diſtinguiſh them carefully. For ſeveral Ores, which, in their natural State, have too little of Specifick Gravity, to make them judg'd worth the

Charge of being wrought, may yet being prepared by Water and Fire afford a Metalline Portion so heavy *in Specie*, that it may give fair hope of containing in it some Portion of Silver, or of Gold; and, in that case a small Proportion of the Former and a much smaller of the Later would render the Ore considerable and make it pretty Rich; tho' not in reference to the quantity it yeilds of the predominant Metal, as Lead, Tin, or Copper; yet in a more absolute Sense, as it may better recompense the Charges of him that shall work it. Which brings into my mind, that some time agoe a piece of Lead Ore, then brought out of *Ireland*, being offered me to judge of; I found it so light in the Lump, that I thought it not at all worthy to be wrought for Lead; but afterward upon Tryal it appeared to be, tho very poor in that Metal, yet so well stor'd with Corpuscles of Silver, that I scrupled not to incourage the Owner to bestow Pains and Cost upon it.

SECT

SECT. V.

BUt there is one Kind of Minerals, that I have obſerved to impoſe on Men ſo often, that I think it neceſſary to take a particular notice of them in this place. For, not to mention Examples, that I might draw out of the Books of Travellers and Navigators, I have met with I know not how many, that have built great hopes, and ſome, (which is worſe) that have been at Charges upon thoſe illuſory Expectations of great matters from *Marcaſites*. And, I remember, I have had ſent me, or brought me, not only from Places nearer home, but from hotter and colder Countries of the *Indies* themſelves, Foſſiles, whereof I was earneſtly deſired to give my Opinion, that I found to be but *Marcaſites*: And many of theſe Foſſiles having two Qualities, that make them very fit to

delude the vulgar, and the unskilful, namely, first, a Multitude of shining streaks, or other glistering parts usually of a Colour near enough to That of Gold, and sometimes to That of Silver; and then, a Ponderousness usually not inferior, at least, to that of true Metalline Ores; *Marcasites*, I say, being thus fitted to delude the unskilful, I have had much ado to undeceive some, that brought or sent me them from *America*, of the pleasing Confidence they had entertained, that these promising Fossiles were Lumps of rich Ore of Gold, or Silver. Wherefore since their Ponderousness (which is the *Criterion* of Minerals, I am now treating of,) is One of the Two chief Things that delude so many, I think it expedient, to subjoyn some few, but various, Instances of the Specifick Gravity of *Marcasites*, whereby it may appear, that some of them are, Bulk for Bulk, far more ponderous than divers true Metalline Ores, that I have try'd, have been found to be. And indeed this

this great Ponderosity has several times invited me, before I made any Artificial Tryal of propounded Fossiles, and sometimes before I took them out of the Bags or Papers to look on them, to judge, tho' perhaps to the Surprize of those that brought them, that they were not true Ores, but *Marcasites*. And, because this Mistake is speciously grounded, and has deceived many, whereof some have undertaken Voyages betwixt *Europe* and the *Indies*, upon confidence of the value of these glistering Stones; I shall decline a little the Method of this Paper, which confines me to the Hydrostatical Way of exploring Minerals, to advertise those whom it may concern, that they may easily try almost any Stone, that, by its great Weight and Lustre, they suspect to be a *Marcasite*, if they put it, either within a Crucible, or, without One, into a well-kindled Fire, and blow now and then upon it with a pair of Bellows. For, by this means, the Sulphur, wherewith

Marcasites

Marcasites are wont to abound, (so that I remember, that even by Destillation in a close Vessel, I had ʒiv of good Brimstone, like the vulgar, out of ℔iij of the Stones) will take Fire, and burn with a Flame for the most part blew, like that of common Sulphur. And, if when it ceases to flame and smoak, you take it out of the Fire and let it cool, you will find it deprived of all the gaudy appearance of rich Metal it had before, and turned to a brittle blackish Substance, differing enough from That of a Metalline Ore, *more strictly so called*. These last words I add, because, in a lax Sense, 'tis easie to shew, that *Marcasites*, at least those that I have tryed, may be looked upon as a kind of Metalline Bodies. For, besides that I have found divers of them to contain Particles of Copper, I found all, that I purposely examined, to contain, and some of them plentifully enough, Corpuscles of Iron or Steel, as plainly appeared, when, after the newly mentioned Calcination,

Calcination, (for with crude *Marcasites* I found not the following Tryal to succeed) I applyed to the pulverized Remains a vigorous Load-stone; to which great multitudes of Martial Corpuscles quickly adher'd. And, I remember, I found in a Catalogue of the Fossiles of *Misnia*, published by the experienced *Kentmannus*, that, under the Head or Title of *Pyrites*, he brings in several *Marcasites*, whereof some contained Copper, others Silver, others Gold, and others both the last named Metals; which brings into my mind, that, having presented, among other English Minerals, a curiously shaped, and very fine *Marcasite*, to a *Virtuoso*, that is now Overseer of one of the Emperors best Mines; He quickly examined it by a peculiar Way, not known to me, hoping to find in it some Gold or Silver; but, instead of that, obtain'd a Portion of running Mercury, which he was pleased to present me, and which, I presume, I may have yet by me.

Tho'

Tho' I thought it needful to give the foregoing Caution about *Marcasites*, for the Reasons before expreſt, yet my Deſign is, only to keep the leſs skilful from being deluded by their promiſing appearance. For otherwiſe I do not deny, but that 'tis poſſible for a skilful Artiſt, to make (at leaſt of ſome ſorts) of them a gainful uſe; *either* by fixing the *Volatile Gold* or *Silver*, that may be found in ſome of them; *or*, by graduating Silver, by their means; *or*, perhaps by ſome other Ways, that I can but gueſs at. But (to add That on this occaſion,) that, for which I much more value *Marcaſites*, is, That (NB) ſomewhat more than bare Conjectures make me think, that, being dexterouſly handled, and perhaps even without Additions, they may afford very noble, as well as uncommon, Medicines; and particularly in Continual Feavers, tho' their Operation be uſually ſcarce ſenſible, but by their good Effects.

SECT.

SECT. VI.

ON this occasion, I must not forbear to give an Advertisement, that may be of good Use to divers Examiners of Ores, especially such, as are Novices in the Art of reducing them. And it is This, that, as to many, who make Tryals of Ores, tho' they much value their own Flux-Powders, or Those that are cry'd up by others, yet they commonly act, as if they expected nothing from those that they prefer, but that they should more than Others facilitate the Fusion of the Ores; as that which being once done, the Metalline part will be separated by its own Weight, or, as it were, Spontaneously. But yet, having purposely examined the Matter more nicely, and compared the Quantities of Metal, that we obtain'd from two Portions of equal Weight of the same Ore,

Ore, we found that those Proportions did very considerably differ, tho' that which yeilded least Metal was flux'd down with a *Fondant* (as the French compendiously call, what Our men, after the Germans, call a Flux-Powder,) that is dear enough, and not undeservedly esteemed, when such Ores are to be handled. And I little doubt, but that from other Metalline Ores, a greater Portion of pure Metal may be obtained by some, but little imployed or known, *Fondants*, and perhaps cheap Ones too, than by Others that are much more in use and famous; Of which I may elsewhere give some Instances: Now, One that first occurs to my Memory, was afforded me, by two equally heavy Portions of the same Lead Ore devoid of Sparr; whereof One, being reduced with a due Weight of *Nitre* and *Tartar* fulminated together, afforded much less of Malleable Lead, than was obtained by means of half or a quarter of the Quantity of Filings of *Mars*, which, for Tryals sake,

I then imployed on the Other; to shew, how much better a Reductive of that kind of Ore, that Metalline Flux was, than even a sharp and fiery fixt Salt.

And yet, (to give you an Instance in a much more precious Mineral than Lead Ore,) I shall add, that having, for Curiosities sake, try'd some Ounces of good native *Cinnabar* finely pulverized; one half with a fixt Alcaly of *Tartar*, and the other with a different Flux-powder, we obtained from the first Parcel twice as much Mercury, as we did from the other half, destilled with another fixt Alcaly; even tho' it were of a Mineral Nature.

Some Observations about Native Gold.

SECT. VII.

About the Hydrostatical Examen of Gold and its Ore.

GOld, being by far the most Noble, and Precious, of Metals, it may be ill taken, if I should here leave the Ore or Mineral, that affords

fords it altogether unmentioned; and therefore, tho' I have but Two, or Three, Observations pertinent to my present Subject, to offer about it, yet I think it may not be useless to say somewhat of that Ore in this place.

I know, there are many learned Men, and even Chymists, that think, there are no such things as *Gold Mines*, properly so called. And, I confess, that I my self was long kept from being confident of the Affirmative. And I was induced to this Diffidence by considering, that tho' having had the Honour for divers Years to be a Member of his Majesties Council for Foreign Plantations, I had the opportunity to converse with a considerable Number of Navigators, and other great Travellers, and with divers Persons, that had setled themselves in the *Indies*, I made it more than once my business to inquire, not, Whether they knew of any *Golden Mines* in the popular sense of the word, for, I knew, that there are in

Hun-

Hungary, *Macedonia*, and some other Countries, *Mines* that afford Gold enough to deserve to be wrought for it: but, Whether there are any real Mines, or Veins, whereof Gold is manifestly the predominant Metal. Having, I say, proposed to many this Question, I was answered, That some of them indeed had heard of such Mines, but none of them had ever seen any. But afterwards I saw some Ore that I judg'd true, that was presented to his Majesty (*Charles* the Second; and I also received from an unknown *Virtuoso*, residing in the *East Indies*, together, with a very civil Letter (which I wished had been more Historical and less Complemental,) among other less valuable pieces of Ore, One in whose Clefts, and a little beyond them, there appear some Lumps, wherein by their Colour, and other Signs, 'tis so apparent, that Gold is the predominant Metal, that I little doubt, but that, if I would spoil the Lump by breaking the Spar, I should find

these Metalline Protuberances Malleable, without the help of the Fire.

But being unwilling to destroy the Entireness of it, I shall make only a few, and short, Remarks about this Ore.

The biggest Piece, and that which was best furnished with Metalline parts, being about an Ounce and a quarter in Weight, contained so great a Proportion of *Spar*, in reference to the Metal, that its Weight to an equal Bulk of Water was but as $2\frac{51}{100}$ to 1.

But somewhat to compensate this Smalness of the Metalline Portion; That, that was of it, seemed to be all Gold, there being no Sign of any other Metal in that Lump of Ore, nor in some lesser Ones that I received with it.

The *Spar* (as our Mine-men use to call that stony Matter, in which the true Ore is immediately lodged,) did not look like the *Spar* of Lead Ore, or that of any other of our English Metals that I have seen, but seemed at first

first view to be a kind of white Marble with a dash of Yellow.

And upon Tryal, I found it to differ more from the *Spar* of Lead Ore, which, with us, is usually White, and and almost *Semi-diaphanous* than in the Colour. For, whereas our *Spar* of Lead Ore is oftentimes so soft or tender, that it may easily enough be cut with a knife, we found the *Sparry* Portion of our Gold Ore to be a Solid stone, and that so hard, that, being struck with a piece of Steel, it would yield Sparks of Fire.

Whereas also I found, that the *Spar* of Lead Ore would be easily enough, and in a short time, (as about a quarter of an hour) calcin'd to a kind of Lime; our Golden *Spar*, tho' kept some hours red hot in a Crucible, did not appear to be at all calcined. And whereas I had formerly observ'd, that I could easily dissolve the *Spar* of Lead Ore in some *Acid Menstruums* and even in destilled Vinegar it self, I did not find, that our

Golden *Spar*, tho' kept divers hours in ſtronger *Menſtruums*, as *Spirit of Salt*, *Aqua Fortis*, and *Aqua Regis*, was diſſolved or manifeſtly wrought upon by any of them; as if it were of a glaſſy Nature, as well as of a very hard One.

A piece of *Spar*, that had ſcarce any Gold at all that could be diſcerned, being Hydroſtatically examined, was in Specifick Gravity to Water, as $2\frac{8}{10}$ to 1. which Ponderoſity does but very little exceed That of white Marble, or That of ſome good *Spar* of Lead Ore that was compared with it.

If I had received a greater Quantity of Gold Ore, I ſhould have given a leſs imperfect Account of this Subject. But theſe Notes, ſuch as they are, may, perchance, not be unwelcome to ſome of thoſe many Engliſh and other Searchers for Mines, that have never ſeen true Gold Ore, or have not had Liberty to make any Tryals upon it, and yet are in Search of Gold Mines, eſpecially in *Jamaica*,

maica, where, if I much mis-remember not, the * inquisitive Gentleman, that conquer'd it for the English, told me, at his return thence, that the Spanish Governour of the Island, when his Prisoner, confessed to him, That there was Mineral Gold, tho' the *Spaniards* did not dig deep for it for want of Workmen.

* General Venables.

SECT. VIII.

BUt by the mention I have made of the true Ore of Gold, I would not discourage any from seeking for that rich Metal in the Veins of some other Metals; because, in divers of these, I know it may sometimes be found blended with predominant Minerals. This may appear by those *Hungarian* Copper Mines of *Cremnitz*, whence a considerable Quantity of Gold is yearly obtained. I have elsewhere also taken

Memoirs for the Natural History of Tin.

notice, that I have seen an English Tin-Ore, Part of which I presented to the King, wherein there lay, in little Cells, a good number of small Leaves or Chips of Gold, which I saw there with pleasure. And tho' the Tin-men, not being able to separate them with Profit, usually melted both the Metals together, and sold the Product for mere Tin; yet an experienced Gentleman, who was Owner of the Mine, assured me, that One of his Workmen, who had many little Children, imployed them with good Profit, to pick the Gold with their small Fingers out of the skilfully broken Ore. And *tho'* Lead-Mines be looked upon, as those, which the Matter, whereof Gold is made, is seldomest found to be near, and does as it were avoid; *yet*, there is a place in *Scotland*, (whose Name I remember not,) where, over a Lead Mine, upon or near the Surface of the Ground, they oftentimes find Grains or bigger pieces of Native Gold without *Spar*; some of which by the ingenious

genious Owners favour, I was Master of, and thought sometimes worthy of being presented to that curious Examiner of Ores, his Highness *Prince Rupert*. And still I have one bit of Native Metal by me, which, if I much mistake not, I had from the same place: which Fossile, tho' I found it Hydrostatically (because being Native I would not melt it) not to be, as the Owner suppos'd, pure Gold; yet Gold is the predominant Metal in it, and the piece weighs forty odd Grains.

Since I wrote the last foregoing Lines, I have, in an old Collection of my Notes, found Three; whereof the *First* is thus set down, *A Grain of Scotch Gold, such as Nature had made it, without any adhering Stone or Spar*, weighed ʒiij -+ 21 Grains: The *Second* thus, *Another Grain of the same Gold, that had here and there some little Stone or Spar sticking to it, and partly inclosed in it*, weighed ʒiij -+ 3 Grains; So that the Heterogeneous Substance being, according to

my Estimate, abated, it weighed about ʒiij: And the Third is subjoyned in these Terms, *A Grain of Scotch Gold weighed in Air*, 43 Grains; in Water, 39 ½ Grains: Differ. 3 + ½ Propor. 12 ⅞ to 1.

This Lightness of a Yellow Metal (heavier than Brass or Silver) deserves a Reflection; but I cannot stay to make it.

It several times happens, that, among the lesser Grains of Gold, that are more properly called *Sand-Gold*, there are found pieces, some of which I have seen, that are singly big enough to be tyed about with an Horse-hair, and so weighed in Water, as Lumps of Ore of other Metals are wont to be. And to such bigger Fragments of Gold, 'tis manifest, by what has been already delivered, that our Hydrostatical Way of exploring may be usefully applyed. For since, according to the famous and diligent *Mersennus*, and some esteemed Writers, pure Gold is to Water of the same Bulk, as (about) 18 to 1; and by

by my *Examen* of very fine Gold, I found, that it equals *about* Nineteen times the Weight of as much Water, (I say, *about*, because I unhappily lost the exactest of my Tryals upon Gold, among those made upon the other Metals in a most exquisite Ballance) as is equal to it in Bulk; it will readily appear, Whether the Fragment propos'd be perfectly pure or not. For, if its Weight amount to near Nineteen times as much Water in Quantity, we may conclude it to be unallayed; and, as it wants less or more of this Ponderosity, we may conclude it to be more or less pure.

SECT. IX.

'Tis known, that, since we began effectually to cultivate the *African* Trade, it frequently brings into these Parts, besides things of less value, considerable Quantities of what, from the most usual Size of it, is

is by many called *Sand-Gold*; but which, by reason of the very unequal Bulks of the Grains, may perhaps justly be called *Fragments of Gold*; since being brought from the Maritime parts, where no Mines of Gold are yet found, they seem to have been broken off and washed away from hidden Veins by the violence of Waters, that, having carried them as far as they were able, left them a Prey to Men. Now, (because that unless it be perhaps brought by, or for, some *Virtuoso*) there is scarce any Gold that comes into *Europe* in Lumps, under the form of *Ore*; but a great deal that is brought from *Guinea*, (and those other parts of *Africk*, which, for that reason, are comprized under the Name of the *Golden Coast*) in the Form chiefly of *Sand* or *Gravel*, grosser or smaller, and partly also of less minute Pieces; it may conduce to the scope of these Papers to take notice, that, in making Estimates of the Genuineness, and the degrees of Purity of these native

Fragments

Fragments of Gold, our Hydroſtatical Way of exploring may be of no ſmall uſe.

For *firſt*, when we have once diſcovered the Proportion between pure or exquiſitely refined Gold, and Water equal to it in Bulk; (which Proportion I have lately given exactly enough, for our preſent purpoſe,) tis eaſie, by our Hydroſtatical Method, to examine the Fineneſs of any other Gold propoſed; ſo, at leaſt, as to know, whether it be perfectly Fine; and if it be not, whether it do conſiderably fall ſhort of perfect Fineneſs. But ſince of this I elſewhere treat, I think it more proper to obſerve in this place, that when once a Man has found the true Specifick Gravity of a parcel of Sand-Gold, (ſmaller or courſer,) whoſe Degree of Fineneſs he knows by Collateral Tryals, or ſome other Means, (whatever they be) He may (as was formerly noted when I ſpoke of Metalline Ores,) take this Specifick Gravity for a Standard, with relation

to

to which, he may make his Estimate of the Fineness of other parcels of the like native Gold, that he is concerned to buy, or to examine. And, by this means, he may oftentimes prevent that chief Fraud of the *Negroes*, whereof several Traders to the Golden Coast are not a little apprehensive; as being in danger to be much damnified by it. For they complain, that, tho' the *Blacks* be otherwise, for the most part, but a dull sort of People; yet they have often made a shift to cheat the Traders, by clandestinely mixing, with the right Sand-Gold, Filings of Copper, or rather of Brass, whose Colour does so resemble that of Gold, that the Fraud is not easily discerned. And in the Account of a late Voyage, made by the French, to the Coast of *Africk*, to Trade especially for Gold, 'tis acknowledged, that the Officers were egregiously cheated by the *Blacks*, who, instead of paying them for the Wares they brought, with Powder of true Gold, gave them Powder of

Brass,

Braſs, or gilt Copper, which thoſe that were not accuſtomed to make Tryal of, are, as the Relater complains, ſuch Wares, in a ſcarce evitable danger to be cheated: as theſe French men confeſs they were in one day to the worth of a thouſand Crowns. But, in regard, that, as Tryal has informed me, Braſs is not quite half ſo heavy as fine Gold of the ſame Bulk; if there be any conſiderable Quantity of Filings of Braſs with the Gold; This Mixture being put into ſuch an Hydroſtatical Bucket, or wide-mouth'd Glaſs, as is mentioned in the Eſſay, will manifeſtly weigh leſs in Water, than if it were all Gold. And by comparing its Specifick Gravity, with that formerly found, to the Grain-Gold pitched upon for a Standard; the greater or leſſer Decrement of the ſuſpected Gold, will help to make an Eſtimate of the Quantity of Braſs, mingled with the natural Gold.

SECT.

SECT. X.

BUt, *tho'* my preſent Undertaking do not oblige me to conſider Sand-Gold, otherwiſe than Hydroſtatically; and, tho' it highly concerns Merchants and Others, that deal in ſo rich a Commodity as Gold, and that is by ſo many ſtudiouſly adulterated, to be furniſht with nice and truſty Ballances; yet, becauſe divers Perſons, eſpecially Sea-men, that trade to the Gold Coaſt and other parts, where Sand-Gold is to be met with, do, (perhaps too often) without being furniſht with good Scales and ſufficient skill to uſe them, venture upon buying ſuch precious Wares; it will not be to depart from my general and main Deſign, which is to ſerve the Publick; if I deviate a little from my Subject, and add to the Hydroſtatical Way, lately propoſed, of examining Sand-Gold,

Two

Two or Three Chymical ways to the same purpose. First, then, if he, that would purchase Sand-Gold, doubts, that there are Filings of Brass (or of Copper) mixt with it; in case he have *Aqua Fortis* at hand, he may quickly discover the Cheat, if there be any. For, 'tis known to Chymists, that *Aqua Fortis* will not work upon Gold, and therefore, if there be Filings of Brass mixt with it, the Operation of the *Menstruum* upon those, together with the Colour betwixt blew and green, it will thereby acquire, will discover the Deceit. But, because if Nature hath mingled much Silver with the Gold, the Proof by *Aqua Fortis* will require Skill, and may puzzle those that want it; I shall add, that good Spirit of Urine may be substituted in its stead. For, I elsewhere shew, that 'twill readily work upon Filings of Copper or Brass in the Gold, and gain from them a fine blew Colour; and this being a *Menstruum* not corrosive, like the other, but harmless to *most* Bodies, and a good Medicine for

for *human* Bodies in ſeveral Diſeaſes, (as the *Jaundice*, *Pleuriſies*, ſome kind of *Feavers*, *Coughs* and *Aſthma's*) may be fit to be carried about in Voyages, and to be preferr'd to *Aqua Fortis*. And, to make the Operation of this Liquor on Filings of Braſs far more quick, than if the Solution be attempted an ordinary Way; I thought upon the following Expedient. I took Filings of Braſs, (and the like may be done with thoſe of Copper,) amounting to the Weight but of Eight or Ten Grains, or perhaps leſs; and having with my Finger ſpread them ſomewhat thin upon a ſmall piece of white Paper, I moiſtned them throughly with good Spirit of fermented (or putrified) Urine, (which will not diſſolve Gold) that, by this means, the Air might promote the diſſolutive Action of the *Menſtruum*; which, accordingly, it did ſo well, that, to the ſurprize of the Beholders, there appeared, in leſs than a quarter of an hour, and ſometimes in a few minutes, a manifeſt, if not

not also a deep and pleasant, blew Colour upon the Paper, or on some of the Filings, (as both. Those that carry with them Spirit of *Hartshorn*, or such other Volatile Alcalys for Medicinal Uses, (as some modern Ship-Chirurgeons do;) may, for a need, imploy That instead of Spirit of Urine. Nay, one may for the same purpose make use of Urine it self never destill'd, if it be Stale and Rank enough, (as it grows to be, sooner in hot Airs than in others:) Since having for Tryals sake moistn'd with such Urine some Filings of Brass, thinly spread on a piece of Paper, there was a manifest Blewness produced in about a quarter of an hour. But I thought also of another Way, which I presumed would be better lik'd by most Traders, as more Commodious; because the Agent, being in a dry Form, cannot, like Spirituous Liquors, be spilt; and tho' it be more easily procur'd, may serve the turn almost as well. This Agent is common *Sal Armoniack*, of which,

when I have occasion to use it, I reduce a greater quantity to Powder, than I guess the quautity of Water, I shall need, will dissolve; that the Liquor may be satiated with the Salt. With this Brine I throughly wet Filings of Brass, (or Copper) after the forementioned manner, thinly spreading them with my Finger on a piece of Paper, or some other fit and flat Body; and in a short time (as about a quarter of an hour or less,) there will appear a Greenish blew Colour, drawn from the Brass by the Liquor: Which (Liquor,) I suppose, I need not tell you, will not work on the Gold, wherewith the Brass is mingled.

SECT. XI.

I Have observed such a Variety of appearances, and disguises, of Metalline Bodies, and some other Minerals, that I would advise those that are

re given to the Search of Mines, nd other Foſſiles, to have their Eyes lways open, when they paſs (eſpecially by Land) from one place to nother; that they may be ready to ake notice of any unknown, or unommon, Foſſile, that they chance to e in their Way; and that having aken it up, they do not neglect to onde it in their hands (which after a little Practice 'twill not be difficult to do, tho' not exactly, yet not nuſefully) and, if they judge it to xceed the Weight of Chryſtal, or Marble, to examine it Hydroſtatically at their firſt Conveniency. For here are in *England*, as well as in livers other Countries, uſeful Foſſiles, that are wont to be overlooked y the unskilful; and I have found in his Kingdom, even upon, or very ear, the Highways, Eagle-ſtones; and ome other Minerals, that were not ſuſpected to be of Engliſh growth. And, I remember, that having occaſion in the Country, to paſs by the Work-houſe of an ingenious Potter,

that I ſometimes imploy'd in his Profeſſion; and having view'd the ground ſomewhat attentively, among ſome other uncommon Foſſiles that I took notice of, I made a diſcovery of *Manganeſe*, or *Magneſia*, whereof I gave the Potter an Advertiſement, which he afterwards thankfully made uſe of, having found the Mineral very proper for the glazing and and colouring of his Veſſels.

Nor was this the only kindneſs that skill in Mineralogy, as little as mine was, enabled me then to do him. For he having invited me to view, very privately, a place where in there was great ſtore of a Foſſil Subſtance, that Men knew not what to make of, becauſe they had no ſeen, nor heard of, the like in *England*: The knowledge I had of ſome *Italian* Mines, made me quickly gueſs What it was that was taken for an unknown Metal. For 'tis true, that this Mineral was not divided into Lumps of ſuch Shapes and Bigneſſes as make glittering Foſſiles paſs for

Stone

Stones among the unskilful, such as are the *Marchasites* whereof they make *Vitriol*, and are found by the Sea-shore, in or near the *Isle of Wight*, and, (tho' not so plentifully) in other parts of *England* (where I have found them;) but ran a great way (and I had not Time or Liberty to try How far) under ground, like a Veine of Metalline Ore. But this notwithstanding, I judg'd the Mineral to be but a *Marchasite*, in a Form, unusual indeed in *England*, but which is not without resemblers in some parts of *Italy*; which Conjecture I found true the same day, by some easie Tryals, that manifested it to abound much more in *Vitriolate* Salt, than any *Marchasite* that I had examined in the form of Stones. So that, tho' I had no opportunity to try, whether or no it contained any better Metal than Iron; yet I concluded, that, *Cæteris paribus*, it might be employed to to make store of *Vitriol*, in far less time, and with far less cost, than the

Marchasites made use use of, in the *Vitriol* Works at *Deptford*, or elsewhere in *England*.

I remember also, that a Mineral of an odd, tho' pretty, appearance, being sent me, whose Species was unknown to the Mine-men that dug it up, I gues's'd that it was a Fossile, that I had not found in a good Printed Catalogue of our *English* Minerals, (namely) the Ore of *Bismuth*. And in this Conjecture some Tryals, purposely made of that Mineral, sufficiently confirmed me; and gave me cause to be sorry, that the Vein, that afforded it, was so very small, as the Diggers found it, of an Ore, that has Properties Curious enough; and is by some famous Chymists affirmed to have some that are, not only Rare, but Wonderful.

But the chief thing that invites me to recommend, in this place, to those that Travel, an heedful eye on the Ore-like, or ponderous Substances that may occur to them, is, That One of the Applications of our general

neral Remark, about the Specifick Gravity of Fossiles, may be extended to an Use, that has not, that I know of, been made by Mineralists, and and which yet I thought fit not to overlook: because I see no need, we should be confin'd to examine only those Fossiles, whereof we can obtain Parcels, big enough to be weigh'd in Water in the entire Body. For besides other Minerals, that may be found profitable to the Physician, the Drugster, or the Mineralist; the Ores, or Wombs, of Metals themselves, may be divers times found disguis'd in the Form of Earth, or of Mud, easie to be dry'd: Which Fossiles, tho' (because they chance not be found in Lumps) unfit to be kept immediately suspended by an Horse-hair; may be conveniently enough examined by the help of a Glass-Jar, whose Weights in Air, and Water, and their Difference, (which gives the Specifick Weight of the Vessel) have been taken once for all, which I usually call an Hydrostati-

cal Bucket. For this Vessel, being almost filled with the propounded Fossile, and carefully counterpoized in the Air, and then thorowly wetted with Water; and when 'tis so, warily let down into the Water, and kept suspended by an Horse-hair to a tender Ballance; when, these things, I say, are done, the Difference between the Weight of the Mineral and Vessel, when they are under Water, and their former Weight, being observed; and the Specifick Weight already found of the Vessel it self in Water, being substracted from that Difference; there will remain the Weight of the Fossile only, (which we here suppose, to be heavier *in Specie* than Water, and not to be dissoluble in it) or the Mineral it self, in that Liquor; and consequently, the Proportion between that Body, and Water of the same Bulk, as is elsewhere sufficiently declared.

SECT.

SECT. XII.

TO manifeſt, that This Expedient may be of uſe in divers Caſes, I ſhall only here obſerve, that a late Author, who hath publiſhed an Account of *Swedland*, declares, that one of the beſt ſorts of *Swediſh* Iron (which, you know, is much eſteemed in its kind) is divers times found, in the Form of a red Mud, at the bottom of Lakes, or far leſſer Stagnant Waters: which I the more readily believe, becauſe I have found ſome Engliſh *Okers* (that paſs but for red Earth, or Stone of that Colour;) to be richer in Iron, than I found ſome famous Ores of that Metal to be. And another experienced Writer, who gives us an Account of the Gold and Silver Mines of *America*, among which he ſpent ſeveral Years, takes notice, that Gold it ſelf is found, from time to time, diſguiſed into a reddiſh

reddish Earth, or is (tho' unsuspectedly) harbored in it. An *Italian* Mineralist, of repute in the last Age, doth also take notice, that a reddish sort of Earth doth sometimes contain a Portion of the richest Metals. I have observed some *European* Diamonds, as many call a sort of clear and finely-Figured Chrystals, to grow in a red Earth; whence I have taken up pretty store of them. And an inquisitive Traveller, who has been in the *Indies*, presented me with a certain Earth, which he affirmed to be from the Diamond Mines, (I presume, in the Kingdom of *Colchonda*) which I found to be also red, and which I made some Tryals of, that belong not to this place.

Vannochio.

SECT. XIII.

But the profitablest Use, that a Mineralists may make of our Hydrostatical Bucket, is, to imploy it

it much in weighing Variety of coloured Sands, and Gravels; particularly, some hereafter to bementioned.

And to let you see, by an easie Instance, how apt we are to overlook Sands for want of trying them by Weight, I shall not tell you, that I have sometimes seen a sort of Sand that was slighted as common or worthless, which, being washed and viewed in a *Microscope*, tho' none of the best, looked like an Aggregrate of small Granats, and perhaps was so; but shall here content my self to instance in that black Sand, that is commonly used in *London* and elsewhere, only to dry up the Ink of Words that have been newly written. For having observed when I had some quantity of this in my hand, that it was manifestly heavier than common Sand; I thought it worth the being examined by the Hydrostatical Bucket; by which Tryal, that which we imployed, appeared to be to Water of the same Bulk, near about as $4\frac{6}{10}$ to 1. And having

having, for Reasons that I cannot stay to mention, judged this Sand to be a Mineral of a Martial Nature, I was confirmed in my Conjecture, by melting it down with two or three parts of Antimony, and casting it into an Iron Cone. But I was more than confirmed in the same Conjecture, when, having try'd it with a vigorous Loadstone, I found it to be far richer in Metal, than any of the *English* Iron Ores I had made Tryal of, and (except perhaps One) than any of the Outlandish: For, having taken, at adventures, some Drams out of a much larger Quantity, and weigh'd it; I found, that at least Seven parts of Eight would easily be taken up by the Magnet. But such Observations as these, are not the things that chiefly move me to recommend the *Examen* of Sands and Gravels to the Mineralist; particularly, those sorts of them, that, being somewhat ponderous, are Reddish or Yellow, especially if they retain those Colours, after they have been made red hot, and quenched in cold Water. But

Therefore to proceed to the mention of richer Sands, 'tis known, That, from the Coast of *Guyny*, *Europæan* Traders, of several Nations, do yearly bring Gold, to a great value, which is washt or pickt out of the Sand. And even in *Europe* there are Rivers, whose Sand is inricht by Grains of Gold, for which the *Tagus* that runs by *Lisbon*, and *Pactolus*, were famous among the Ancients. I knew an industrious Chymist, who owned to me, that he got Gold with Profit, from the Sand, which he found in some places of the Banks of the *Rhine*: and there is a litle River in *Savoy* proceeding from the Mountains there, on whose Banks, after a Land flood, I saw poor People busie themselves in seeking for Grains of Gold. Some Tryal, (also) that I caused purposely to be made, confirmed me in a Conjecture, which possibly may hereafter prove Beneficial to many; namely, that the Sands of divers places, if they be Skilfully treated by a dextrous Chymist, may afford

afford much more Gold, than is pickt or washt, out of them in Form of Grains. For besides, that there may be many Atoms, or Corpuscles, of Gold that are so very minute, and stick so close to Grains of Sand, that they are neither taken notice of by the Eye, nor separable by washing, and picking; besides this, I say, there may, as I conceive, be many Particles of Gold incorporated with the Body of the Sand, which may be a Kind of Womb for matter of a Golden Nature, that a skilful Artist, by the help of proper Additaments, may separate with Profit especially, if, with *Litharge* or *Minium*, he first reduce the Sand to a Glass, and then take care to get the *Volatil Gold*, by giving it a pure Body fit to retain and fix it, such as is fine Silver: Out of which, I remember, we separated by *Quartation*, (tho' without Profit, because of the Charges, and of the small Quantity we could work with at once,) from as much vitrified Sand, and two or three fluxing Additaments

ditaments of ſmall price, as were contained in one Crucible, (that broke too, before Operation was near done,) ſixteen Grains of pure Gold; that you may yet ſee, if you deſire it.

SECT. XIV.

IT need not ſtartle you, that, in reciting this Experiment, I made mention of *Volatile Gold*. For, tho', I know, that divers learned Men, and ſome able Chymiſts themſelves, look upon it as a Fictitious thing; and that ſeems to bear a kind of Contradiction in its very Name; in regard of the perfect Fixity they preſume to be an Eſſential property of Gold: yet I do not ſcruple to diſſent from them, being warranted ſo to do by my own Experience. For, I have, more than once, made uſe of a Way, wherein, by the help of an Additament, inconſiderable as to Bulk, and leſs as to Weight; one may, without

out a naked Fire, and in a Glass retort, sublime Gold, (not prepared by previous Calcination) sometimes in the Form of a yellow, or golden coloured, Salt; and sometimes, when the Operation succeeded better, in the Form of thin Chrystals prettily shapt, Glossy, and as red as Rubies. But this upon the by; it may perhaps be more useful to Searchers of rich Fossiles not found in Lumps, if I take this occasion to observe, that when they meet with Sands, Earths, Mineral Fragments, *&c.* that considerably exceed Chrystal in Specifick Gravity; and by the Place wherein they are found, or by other Tokens, give hopes of their containing Corpuscles of a golden Nature: When this, I say, happens, it will not be adviseable, hastily to reject such Bodies; but rather carefully to try, Whether they do not deserve a better Usage. For, having sometimes had the opportunity to discover Corpuscles of *Mars*, as Chymists call Iron and Steel, in a far greater Variety of

Fossiles,

Fossiles, and of Disguises, than even many noted Chymists would have imagined, or some of them could, upon heedful Tryal, discover; I was much confirmed in my Suspicion, That Corpuscles of a Golden Nature may be concealed in divers Bodies, which are thought not to contain *any* Metal; and that in more of those Minerals, that are lookt upon as Ores of some *other* Metal, because of its being manifestly Predominant, there may be mingled pretty store of Particles of Gold or Silver; which (because of the greater Quantity of that other Metal, or Mineral, that doth, as it were, cover, or disguise them;) lye unperceived, & usually unsuspected, by Persons not very well acquainted with such Matters; and yet may, by One that is very skilful, be separated even with Profit.

SECT. XIII.

But the Grounds of the forementioned Suſpicion being as yet but Conjectural, I ſhall decline the particular mention of them in this place; and ſhall rather *Adviſe*, with reference to Ores in General, that thoſe that would apply the Hydroſtaticks to Them, do labour to procure Samples of the Ores of differing Mines, eſpecially if they be found in the ſame Country; and do either by Tryal or ſtrict Enquiry inform themſelves, what Proportion of the Metal, that denominates them, they contain. For theſe Portions of Ores and Minerals, being carefully weighed in Air and Water, and their Specifick Gravities, being thereby made known, they may ſerve for a kind of Standard, by Compariſon whereto we may oftentimes

tentimes make not altogether unuſeful Eſtimates of the Metalline Portions contained in other Parcels of Ore, of that *Species*, whether afforded by the ſame Mine, or Vein of it, or by any other of the ſame Metal)Hydroſtatically examined.

For Inſtance, our Engliſh Lead-Ores, that are worth taking notice of, may be, for diſtinction ſake, divided into Three Kinds or Orders, and in each of theſe, there may be allowed a Latitude for greater, or leſſer, Degrees of Goodneſs. The *Firſt* ſort is of thoſe Ores, that, in the ordinary Way of melting, hold ſome of them from 30 ℔ of Lead, in an hundred Weight of Ore, to 40; and others to 45 ℔ of the ſame Metal, and theſe by ſeveral are ſlighted, as mean; and ſcarce, if at all, worth working; eſpecially, thoſe that hold under 35 or 40. As for the *Second* ſort, that reaches from 45. to 60 ℔, in the hundred; the moſt uſual Proportion, I have found in many Tri-

als hath been about half the Weight of the Ore in clean and Malleable Lead. Theſe Ores are thought in differently good and worth working: But other Ores compriſed in this Second ſort, held about 55, and ſome near 60, and theſe were lookt upon, not only as Good, but pretty Rich. And for the *Third* Sort, it conſiſts of thoſe that yield from 60 to 80. in the hundred, and theſe Ores are juſtly reputed very Rich, (in lead) eſpecially theſe that come any thing near 80; for, I confeſs, I never met with any that reacht ſo far, but was aſſured by an ingenious & skilful Gentleman, Maſter of his Majeſties Royal Mint, that he had found ſome ſuch upon Tryal. But for me, I think that I have not above twice or thrice met with any that yielded me above 75. Theſe lookt exceedingly Promiſing, as if they were all Metal, and I obſerved, whether the thing were caſual or not, ſome Lumps to be compoſed of

of divers great Cubes like Dice, ſticking very hard to one another.

The Conſiderations, that moved me to offer the Advice given at the beginning of this Section, invited me to make Reſearches of the Specifick Gravity, *not only* of divers Engliſh Ores, as of Lead, Tin, &c. Of which I had carefully made a Collection, (that was loſt by a ſudden Fire, broke out in the place where I kept them,) but of the Ores that were preſented me from ſeveral Countries, both in *Europe* and *America*; as *Swediſh* Copper and Iron Ores, *German* Silver and Tin-Glaſs Ores; *Hungarian* Antimonial Ores; *New Engliſh* Lead, Iron, and Copper Ores, &c. The Effects of ſome few of which Reſearches, that chanced to come to hand, whilſt I was ſeeking for ſome Hydroſtatical Tryals of Drugs, I thought it not amiſs to inſert in a Table annext to the *Medicina Hydroſtatica*; becauſe perhaps they may be of ſome

uſe, in making a previous Conjecture, about a Mines being, or not being, likely to be wrought with Profit, *all other things concurring, that ſhould do ſo.* Which laſt Clauſe I deſire ſhould be taken notice of; becauſe there are divers other Circumſtances, beſides the Proportion of the Metalline part in the Foſſile, that are fit to be conſidered, [as, *the* Plenty, or Scarcity, of the Mineral; *the* Eaſineſs or Difficulty of coming at it, becauſe of *its* depth, or its being, or not being troubled with Waters, &c; *its* Nearneſs to Plenty of Fuel; and the Conveniency of Water to drive Mills; its Nearneſs to, or Remoteneſs from, the Sea, or ſome Navigable River, convenient for its Tranſportation, to omit other important Circumſtances] before One begins to work a Mine; which as they happen to be Commodious, or Inconvenient, may render the Attempt Adviſeable, or Imprudent.

But

But Sir, I perceive, (tho' late) that I have forgot, I was to write, not a Book of the Tryal of Ores, and other Minerals, but a moderately, sized Letter, about an Hydrostatical Way of Exploring their Specifick Gravity. And therefore, to avoid increasing the already too great Prolixity of this Paper, by making an Apology for it, I shall lengthen it, only to beg you to Pardon it, and to look upon the Writer, as

SIR,

Your most humble and

Obedient Servant

R. B.

Advertisement.

TO give the Curious the Satisfaction of seeing at one view, and so of easily comparing together, the Specifick Gravitys of a good Number and Variety of Bodies; and to save them the labour of turning over many Leaves of the foregoing Tract, to find the particular Body, whose Ponderosity they desire to know; I have caused to be annexed a Table, containing in an Alphabetical Order (tho' not a scrupulously exact One,) the Names of the Drugs, and other Bodies, whose Gravities are delivered in the foregoing Papers; without scrupling to add some others, that I chanced to light on, in turning over some of my old and forgotten Notes.

But

But I must to the following Table premise this Advertisement, (warranted by several passages of the foregoing Papers here laid together) That 'tis not to be expected, Every one that shall try the Specifick Gravities of the Bodies here mentioned, shall find all of them to be precisely the same, that the Table exhibits: Since, (not to mention, that perhaps every Experimenter will not imploy so much Care, and be assisted with so much Use, in making Hydrostatical Tryals, as Those this Table consists of were made with) the Difference, that may sometimes be found between his Tryals and mine, may very probably be imputed to that Variety of Texture and Compactness, that may be found in several Bodies of the same kind, or Denomination; neither Nature, nor Art, being wont to give all the Productions that bear the same Name, a Mathematical preciseness, either in Gravity or in other Qualities.

The TABLE.

A	Weight In Air in Gr.	In Water in Grains.	Proportion.
Amber	306	12	$1\frac{4}{100}$ to 1.
Agat	251	156	$2\frac{64}{100}$ to 1.
A piece of Allom-stone	$280\frac{3}{4}$	$152\frac{1}{4}$	$2\frac{18}{100}$ to 1.
Antimony good and supposed to be Hungarian One--	391	295	$4\frac{7}{100}$ to 1.
B			
Bezoar stone . . .	187	61	$1\frac{48}{100}$ to 1.
A piece of the same--	$56\frac{1}{2}$	22	$1\frac{64}{100}$ to 1.
A fine Oriental one --	172	60	$1\frac{53}{100}$ to 1.
Another	237	61	$1\frac{34}{100}$ to 1.
C			
Coral red . . .	$129\frac{1}{4}$	$80\frac{1}{4}$	$2\frac{63}{100}$ to 1.
Chrystal	256	140	$2\frac{21}{100}$ to 1.

Cornelian

	Weight In Air in Gr.	*In Water in Grains.*	*Proportion.*
Cornelian . . .	148	103	$3\frac{29}{100}$ to 1.
Calculus humanus---	2570	1080	$1\frac{72}{100}$ to 1.
Coco-shell . . .	331	85	$1\frac{34}{100}$ to 1.
Native Crabs Eyes .	$77\frac{1}{2}$	$36\frac{1}{2}$	$1\frac{89}{100}$ to 1.
Crabs Eyes Artificial.	$90\frac{1}{2}$	54	$2\frac{48}{100}$ to 1.
Calx of Lead . . .	$138\frac{1}{2}$	123	$8\frac{94}{100}$ to 1.
Copper Stone . . .	$65\frac{1}{2}$	$49\frac{1}{2}$	$4\frac{09}{100}$ to 1.
Common Cinnabar--	802	702	$8\frac{1}{50}$ to 1.
Cinnabar of Antimony	197	169	$7\frac{3}{100}$ to 1.
Cinnabar Native---	197	171	$7\frac{57}{100}$ to 1.
Coral White . . .	336	204	$2\frac{54}{1002}$ to 1.
Another piece fine --	139	85	$2\frac{57}{100}$ to 1.
Calculus humanus --	302	97	$1\frac{47}{100}$ to 1.
Copper Ore . . .	1436	1090	$4\frac{15}{100}$ to 1.
Copper Ore Rich . .	413	314	$4\frac{17}{100}$ to 1.
Cinnabar Native, very sparkling . .	226	194	$7\frac{6}{100}$ to 1.
G.			
Gold Ore not Rich, brought from the East Indies . . .	1100	682	$2\frac{63}{100}$ to 1.

Ano-

	Weight In Air in Gr.	In Water in Grains.	Proportion.
Another Lump of the same	1151	717	$2\frac{44}{100}$ to 1.
Granati Minera	217	147	$3\frac{4}{10}$ to 1.
Granate Bohemian			$4\frac{36}{100}$ to 1.
H			
Hæmatites Englisſh	1574	1156	$3\frac{36}{100}$ to 1.
I			
Ivory	$173\frac{1}{2}$	83	$1\frac{91}{100}$ to 1.
L			
Lapis Manati	450	293	$2\frac{86}{100}$ to 1.
A Fragment of the ſame	$218\frac{1}{2}$	123	$2\frac{29}{100}$ to 1.
Another	345	197	$2\frac{33}{100}$ to 1.
Another from Jamaica	2011	1127	$2\frac{32}{100}$ to 1.
Lapis Lazuli one piece	385	256	$2\frac{98}{100}$ to 1.
Lead Ore	686	590	$7\frac{14}{100}$ to 1.
Another			

Lapis

	Weight In Air in Gr.	*In Water in Grains.*	*Proportion.*
Lapis Calaminaris--	477	380	$4\frac{92}{100}$ to 1.
Lapis Judaicus . .	$261\frac{2}{1}$	164	$2\frac{69}{100}$ to 1.
M			
Marcasites . . .	814	631	$4\frac{41}{100}$ to 1.
Another from Stalbridge . . .	243	189	$4\frac{1}{2}$ to 1.
Another more shining than ordinary. . . .	287	227	$4\frac{78}{100}$ to 1.
Mercury reviv'd from Ore . . .			
Manganese a piece--	321	230	$3\frac{11}{100}$ to 1.
Mineral Cornish like a shining Marcasite	145	129	$9\frac{6}{100}$ to 1.
O			
Osteocolla	195	108	$2\frac{44}{100}$ to 1.
Ore Silver choice from Saxony . .	458	366	$4\frac{27}{100}$ to 1.
Another Piece . . .	1120	960	7 to 1.

	Weight In Air in Gr.	In Water in Grains.	Proportion.
Ore Lead from Cumberland *Rich*	1872	1586½	$\frac{14}{100}$ to 1.
R			
Rhinoceros horn	8563	4260	1 $\frac{29}{100}$ to 1.
Rock-Chrystal, another Piece	256	140	2 $\frac{12}{100}$ to 1.
S			
Saphir			
Seed-Pearl			
Sulphur vive.	371	185	2 to 1.
Germane very fine	306	152	1 $\frac{94}{100}$ to 1.
Slate Iriſh	779	467	2 $\frac{42}{100}$ to 1.
T			
A Piece of Talc like Lapis Amianthus	596	334	2 $\frac{48}{100}$ to 1.
Talc Venetian	802	508	2 $\frac{72}{100}$ to 1.
Talc Jamaican	1857	1238	3 to 1.

New

	Weight In Air in Gr.	*In Water in Grains.*	*Proportion.*
New Engliſh Tin Ore, Mr. Huberts.	812	613	$4\frac{13}{100}$ to 1.
Tin Ore black Rich .	1293	984	$4\frac{18}{100}$ to 1.
Another piece Choice.	2893	2314	5 to 1.
Tutty a piece . . .	104	83	5 to 1.
Tin-glaſs	468	419	$9\frac{11}{100}$ to 1.

V

Vitrum Antimonii per ſe	$357\frac{1}{2}$	$282\frac{1}{2}$	$4\frac{76}{100}$ to 1.
Vitriol Engl. *a very fine piece* . .	1093	512	$1\frac{88}{100}$ to 1.
Unicorns horn a piece	407	195	$1\frac{91}{100}$ to 1.

Poſt-

POSTSCRIPT.

When I began to send the Essay, called, Medicina Hydrostatica, *to the Press, and drew up the foregoing Preface to it, I intended it should in the same Book or Volume, be accompany'd by another Help or two, to explore, and Improve the* Materia Medica. *But when the Essay it self, and the annex'd Epistle about a previous Exploration of Ores had been Printed off; I could not but perceive, that the Bulk of those two Tracts so far exceeded what I expected, that if I subjoyned what I at first designed to add to it, it would prove a mis-shapen Book, and inconvenient to be open'd, wherefore it seemed expedient to divide the whole intended Work into two Volumes or Tomes, whereof what had already past the Press, should make the first, which that it might be the sooner serviceable should forthwith come abroad by it self, and the Second should consist partly of the other Papers abovementioned, as relating to the* Materia Medica, *and partly, of a Supplement to the first Tome, containing divers Historical* Paralipomena, *that by mistake were omitted, and are fit to be there supply'd out of a fuller Copy, then that which by an Oversight was made use of at the Press.*

FINIS.

A CATALOGUE OF THE Philosophical BOOKS and TRACTS,

Written by the Honourable *ROBERT BOYLE* Esq;

Together with the

ORDER OF TIME

Wherein each of them hath been Publish'd respectively.

To which is added,

A CATALOGUE

Of the THEOLOGICAL BOOKS, Written by the same Author.

London: Printed for *Sam. Smith*, at the Sign of the Prince's Arms in St. *Paul's* Church-yard. 1690.

Advertisements of the Publisher.

1. *Many ingenious Persons, especially Strangers, having pressingly endeavour'd to procure a Catalogue of the Honourable* Mr. Boyle's *Writing's; and the Author himself being not at leasure to draw one up; 'twas thought it might be some satisfaction to those Inquirers, if I publish'd the following List, as it was drawn out, for his own use, of the* Philosophical Transactions, *as well as the Printed Volumes, by an ingenious* French *Physician, studious of the Authors Writings, some of which he Translated and Printed in his own Language.*

2. *The Letter* L. *affixt in the Margin, denotes the Book related to, to have been Translated, and Publish'd in the Latin Tongue also. Several of the rest having likewise been Translated into Latin, but not yet Publish'd.*

3. *Those that have an Asterisk prefix'd to them, came forth without the Authors Name, tho' 'tis not doubted but they are His.*

4. *Such as have this Mark* ☞ *prefix'd to them, are Sold by* Samuel Smith *at the* Prince's Arms *in* St. Pauls Church-yard.

5. *Divers of those mention'd, as drawn out of the* Transactions, *did probably come abroad in Latin; some of the Transactions themselves having been publish'd in that Language.*

New

A Catalogue of the Philosophical Books and Tracts.

NEw Experiments Phisico-Mechanical, touching the Spring and weight of the Air, and its Effects, (made for the most part in a new Pneumatical Engine) written by way of Letter to the Right Honourable *Charles* Lord Viscount of *Dungarvan*, Eldest Son to the Earl of *Cork*, by the Honourable *Robert Boyle* Esq;

A Defence of the Doctrine, touching the Spring and Weight of the Air; propos'd by the Author in his New *Phisico-Mechanical Experiments*; against the Objections of *Franciscus Linus*, wherewith the Objectors *Funicular Hypothesis* is also examin'd.

An Examen of Mr. *Tho. Hobbes*'s *Dialogus Physicus de Natura Aeris*, as far as it concerns the Authors Book of New Experiments, touching the Spring of the Air; with an Appendix touching Mr. *Hobbes*'s Doctrine of Fluidity and Firmness.

These three together in a Volume in 4°, being a Second Edition; The First at *Oxford* 1662, had been publish'd, *Anno* 1660. The Two others at *London*, 1662, had been publish'd, *Anno* 1661.

The Sceptical Chymist, &c. 1661.

L ☞ Physiological Essays, or *Tentamina*, Written and Collected upon divers Times and Occasions, with an History of Fluidity and Firmness, in 4°. 1662.

L ☞ An Experimental History of Colours begun, 8°. 1663

Some Considerations touching the usefulness of Experimental Natural Philosophy, propos'd in a familiar Discourse to a Friend, by way of Invitation to the Study of it; a Second Edition 4°. *Oxford*, 1664. The first had been publish'd 1663.

☞ Of the usefulness of Natural Philosophy, the Second Part; the First Section, of its usefulness to Physick, with an *Appendix* to this First Section of the Second Part, 4°. 1669.

Of the Usefulness of Experimental Natural Philosophy, &c. the Second Tome, containing the latter Section of the Second Part, 4°. *Oxford.* 1671.

The First Volume of these three Books contains Five Essays.

The First, Of the Usefulnness, &c. Principally as it relates to the Mind of Man.

The Second, A Continuation of the former.

The Third, A further Continuation.

The Fourth, A requisite Digression concerning those, who would exclude the Deity from intermedling with Matter.

In the Fifth, The Discourse, interrupted by the late Digression, is resum'd and concluded.

The

The Second Volume contains likewise five Essays.

The first, Of the Usefulness, &c. As to the Physiological part of Physick.

The second, As to the Pathological part of Physick.

The third, As to the Semeiotical part of Physick.

The fourth, As to the Hygieinal part of Physick.

The fifth, As to the Therapeutical part of Physick, in 20 Chapters.

The Third Volume contains six Essays.

The first, General Considerations about the Means, whereby Experimental Philosophy may become useful to Human Life.

The second, Of the usefulness of Mathematicks to Natural Philosophy.

The third, Of the usefulness of Mechanical Disciplines to Natural Philosophy.

The fourth, That the Goods of Mankind may be much encreas'd by the Naturalists insight into Trades, with an Appendix.

The fifth, Of doing by Physical Knowledge, what is wont to require Manual Skill.

The sixth, Of Mens great Ignorance of the Uses of Natural Things.

An Experimental History of Cold, and some Discourses concerning New Thermometrical Experiments, and Thoughts about the Doctrine of Antiperistasis; with

An Examen of Mr. *Hobbes*'s Doctrine touching Cold, a second Edition, 4°. 1665.

Attempts of a way to convey Liquors immediately into the Mass of Blood, communicated in the Philosophical Transactions of *December* the 4*th*. 1665.

Observations and Experiments upon the Barometer or Ballance of Air, invented, directed, and begun, *Anno* 1659 communicated to Dr. *Beal* that continu'd them, and mention'd in the Transactions of *February* the 12*th*, and *March* the 12*th*, 1666.

Hydrostatical Paradoxes made out by new Experiments, for the most part Physical and easie, occasion'd by Monsieur *Pascbal*'s Tract of the *Equilibrium* of Liquors, and of the Weight of the Air, 1666.

An account of an Earth-quake near *Oxford* and the Concomitants thereof, communicated in the Philosophical Transactions of *April* the 2*d*. 1666.

New Observations and Directions about the Barometer, in the same.

General Heads for a Natural History of a Countrey, great or small, communicated in the same.

The Origine of Forms and Qualities illustrated by Considerations and Experiments, in two Parts, 8°. 1666.

A way of preserving Birds, taken out of the Egg, and other small *Fœtus*'s, communicated in the Philosophical Transactions of *May* 7*th*. 1666.

An Account of a new kind of Baroſcope, which may be call'd Statical, and of ſome advantages and conveniences it hath above the Mercurial, communicated in the Phyloſophical Tranſactions of *July* the 2*d*. 1666.

A new Frigorific Experiment, ſhewing how a conſiderable degree of Cold may be ſuddenly produc'd, without the help of Snow, Ice, Hail, Wind or Nitre, and that at any time of the year, communicated in the Phyloſophical Tranſactions of *July* 18*th*, 1666.

Tryals propos'd to *Dr. Lower* for the improvement of transfuſing Blood out of one live Animal into another, communicated in the Phyloſophical Tranſactions of *February* the 11*th*, 1666.

Free Conſiderations about Subordinate Forms, being an *Appendix* to the Origine of Forms and Qualities publiſh'd laſt year, and reprinted with this, 1667. &c.

A Letter to the Author of the Phyloſophical Tranſactions, giving an Information of ſome Experiments which he had made himſelf ſeveral years ago, by injecting acid Liquors into Blood, upon the occaſion of thoſe communicated by Signior *Fracaſſati*, in a Letter written from *Oxford*, *October* 19*th*, 1667.

New Experiments concerning the Relation between Light and Air, (in ſhining Wood and Fiſh) in a Letter from *Oxford* to the Publiſher of the Phyloſophical Tranſactions of *January* the 6*th*, 1668.

A Continuation of the same Letter in the Philosophical Transactions of *February* 10*th*, 16 8.

A Continuation of new Experiments, Physico-Mechanical, touching the Spring and Weight of the Air, and their Effects; The first part. With a *Discourse* of the Atmospheres of Consistent Bodies, *Oxford*, 1669.

An Invention for estimating the Weight of Water with ordinary Ballances and Weights, in the Philosophical Transactions of *August* the 16*th*. 1669.

L Certain Phylosophical Essays and other Tracts, a second Edition; with a *Discourse* about the Absolute rest of Bodies, 4°. *London* 1669. The first Edition had been published, *Anno*, 1662.

New Pneumatical Experiments about Respiration, upon *Ducks*, Vipers, Frogs, *&c.* communicated in the Phylosophical Transactions of *August* 8. 1670.

L A Continuation of the same Experiments in the Phylosophical Transactions of *September* the 12*th*. 1670.

Tracts: About the Cosmical Qualities of Things: The Temperature of the Subterraneal and Submarine Regions, and the bottom of the Sea; together with an Introduction L to the History of particular Qualities, &°. *Oxford* 1670.

Tracts: A Discovery of the admirable Rarefaction of the Air (even without Heat:) New Observations about the duration of the Spring of the Air. New Experiments touching the

the condensation of the Air by mere Cold, and its compression without Mechanical Engines, and the admirably differing extensions of the same quantity of Air, rarefied and compress'd, 4°. *London*, 1670.

An Essay about the Origine and Virtues of Gems, 8°. *London*, 1672.

Some Observations about shining Flesh, both of Veal, and Pullet, and that without any sensible Putrefaction in those Bodies, communicated by way of Letter to the publisher of the *Philosophical* Transactions, in the Transactions of *December* the *16th*. 1672.

A new Experiment concerning an effect of the varying weight of the Atmosphere upon some Bodies in the Water, the Description whereof was presented to the Lord *Broncker*, *Anno* 1671. Suggesting a conjecture, that the alterations of the very Weight of the Air, may have considerable Operations, even upon Mens Sickness or Health, communicated in the *Philosophical* Transactions of *February* the *24th*. 1673.

Tracts: Containing new Experiments, touching the Relation between Flame and Air, and about Explosions. An Hydrostatical Discourse, occasion'd by some Objections of Dr. *Henry Moor*, *&c.* to which is annexed an Hydrostatical Letter about a way of weighing Water in Water: New Experiments of the positive, or relative, levity of Bodies under Water: Of the Airs-Spring on Bodies under Water, and about the differing

ring Preſſure of heavy Solids and Fluids, 8°. *London*, 1672. 1691.

L ☞ Eſſays of the ſtrange Subtilty, great Efficacy, and determinate Nature of *Effluviums*; to which are annex'd new Experiments to make the parts of Fire and Flame, Stable and Ponderable, with Experiments about arreſting and weighing of *Igneous Corpuſcles*; and a Diſcovery of the perviouſneſs of Glaſs to ponderable parts of Flame, 8°. *London* 1673.

A Letter of *September* the 13*th*, 1673 concerning Ambergreece, and its being a Vegetable Production, mention'd in the Phyloſophical Tranſactions of *October* the 6*th*, 1673.

L ☞ Tracts: Obſervations about the ſaltneſs of the Sea: An account of the Statical Hygroſcope, and its Uſes, together with an Appendix about the force of the Airs Moiſture, and a Fragment about the Natural and Preternatural ſtate of Bodies. To all which is premis'd a Sceptical Dialogue about the poſitive or privative Nature of Cold, 8°. *London*, 1674. 1691.

L A Diſcourſe about the Excellency and Grounds of the Mechanical Hypotheſis, occaſionally propos'd to a Friend, annex'd to Another entituled, *The Excellency of Theology, compar'd with Natural Phyloſophy*, 8°. *London* 1674.

An account of the two ſorts of *Helmontian Laudanum*, together with the way of the Noble Baron *F. M. Van Helmont* (Son to the famous

famous *John Baptiſta*) of preparing his *Laudanum*, communicated in the Phyloſophical Tranſactions of *October 26th.* 1674.

Tracts: Containing, 1. Suſpicions about ſome hidden Qualities of the Air, with an Appendix touching Cœleſtial Magnets, and ſome other particulars. 2. Animadverſions upon Mr. *Hobbes's Problemata de vacuo.* 3. A Diſcourſe of the Cauſe of Attraction by Suction, 8°. *London*, 1674. 1691. L

Some Phyſico-Theological conſiderations about the poſſibility of the Reſurrection, annex'd to a Diſcourſe, entituled, *The Reconcileableneſs of Reaſon and Religion*, 8°. *London* 1675.

A Conjecture concerning the Bladders of Air, that are found in Fiſhes, communicated by *A. F.* and illuſtrated by an Experiment, ſuggeſted by the Author in the Phyloſophical Tranſactions of *April* the *26th*, 1675.

A New Eſſay-Inſtrument, invented and deſcribed by the Author, together with the Uſes thereof, in three Parts.

The firſt ſhews the occaſion of making it, and the Hydroſtatical Principles 'tis founded on,

The ſecond deſcribes the Conſtruction of the Inſtrument.

The third repreſents the Uſes; which, as relating to Metals, are

1. To diſcover whether a propos'd Guinea be true, or counterfeit.

2. To examine divers other Gold Coins, and particularly half Guinea's. 3. To

3. To examine the new English Crown pieces of Silver.

4. To estimate the goodness of Tin and *Pewter*.

5. To estimate Alloys of Gold and Silver, and some other Metalline Mixtures. All this maketh up the *Philosophical* Transactions of *June* 21. 1675.

Ten new Experiments about the weaken'd Spring, and some unobserved Effects, of the Air, where occur not only several Tryals to discover, whether the Spring of the Air, as it may divers ways be increas'd, so may not by other ways than Cold, or Dilatation be weakned; but also some odd Experiments to shew the change of Colours producible in some Solutions and Precipitations by the Operation of the Air, communicated in the *Philosophical Transactions* of *Decemb.* 27. 1675.

An Experimental Discourse of Quicksilver, growing hot with Gold, English and Latin, communicated in the *Philosophical Transactions* of *February* 21. 1676.

Experiments, Notes, *&c.* about the Mechanical Origine or *Production* of divers particular Qualities, amongst which, is inserted a *Discourse* of the Imperfections of the Chymists Doctrine of Qualities, together with some Reflections upon the Hypothesis of *Alcali* and *Acidum*, 8°. *London*, 1676. 1690.

This *Discourse* comprehends Notes, *&c.* about the Mechanical *Origene* and *Production* of Cold.

Of

Of Heat.
Of Tasts.
Of Odours.
Of Volatility.
Of Fixtness.
Of Corrosiveness.
Of Corrosibility.
Of Chymical *Precipitation.*
Of Magnetical Qualities.
Of Electricity.

New Experiments about the superficial Figures of Fluids, especially of Liquors contiguous to other Liquors: Likely to conduce much to the *Physical* Theory of the grand System of the World, communicated in the *Philosophical* Transactions of *January* 25*th.* $167\frac{6}{7}$.

A continuation of the same Experiments in the *Philosophical* Transactions of *February* the 26*th.* $167\frac{6}{7}$.

The Sceptical Chymist, or Chymico-*Physical* Paradoxes, touching the Experiments whereby vulgar Spagyrists are wont to endeavour to evince their Salt, Sulphur and Mercury to be the true Principles of Things; to which in this Second Edition are subjoyned divers Experiments and Notes, about the Producibleness of Chymical Principles, 8°. *Oxford*, 1680. 1690.

A Second Continuation of new Experiments Physico-Mechanical, in which, various Experiments, touching the Spring of the Air

Air, either compreſs'd or Artificial, are contain'd, with a Deſcription of new Engines to perform them, 1680.

L ☞ The *Aerial Noctiluca*, or ſome new *Phænomena*, and a Proceſs of a factitious Self-ſhining Subſtance, 8°. *London.*

L ☞ The Glacial or *Icy Noctiluca*, with a Chymical Paradox founded on new Experiments, whence it may be made probable, that Chymical Principles may be converted one into another, 8°. *London*, 1680.

L ☞ Memoirs for the Natural Hiſtory of Human Blood, eſpecially the Spirit of that Liquor, *London*, 1684.

L ☞ Experiments and Conſiderations about the Poroſity of Bodies, in Two Eſſays: The former of the *P*oroufneſs of Animal Bodies; The other of the Porouſneſs of Solid Bodies, 8°. *London*, 1684.

☞ Short Memoirs for the Natural Experimental Hiſtory of Mineral Waters, 8°. 168⅘.

An Hiſtorical Account of a ſtrangely Self-moving Liquor, communicated in the Philoſophical Tranſactions of *November* the 26*th*. 1685.

L ☞ Of the Reconcileableneſs of Specifick Medicines, to the Corpuſcular Philoſophy, to which is annex'd a Diſcourſe about the advantages of the uſe of Simple Medicines, propos'd by way of Invitation to it, 8°. *London*, 1685.

☞ An Eſſay of the great Effects of Languid and

and unheeded Motion. To which is annex'd an Experimental Discourse of some unheeded Causes of the Salubrity and Insalubrity of the Air and its Effects, 8°. *London*, 1685, 1690.

A free Inquiry into the vulgarly receiv'd Notion of Nature, in an Essay address'd to a Friend, 8°. *London*, 168⅝. *L

A Disquisition about the Final Causes of Natural Things. With an Appendix of some Uncommon Observations about vitiated Sight 8°. *London*, 198⅞. *

Medicina Hydrostatica: Or, Hydrostaticks, applyed to the *Materia Medica*, Shewing, How by the Weight that divers Bodies us'd in Physick, have in Water; one may discover, Whether they be Genuine or Adulterate. To which is subjoyn'd, a previous Hydrostatical way of estimating Ores, 8°. *London*, 1690.

Advertisements.

Because among those that willingly read the Authors Writings, there are some that relish those most, (as most suitable to their Genius, addicted to Religious Studies) that Treat of Matters relating to Divinity: the Publisher thinks fit to gratify them with a Catalogue of those Theological Books that pass for Mr. Boyle's, *because they were ascrib'd to him, and never positively disown'd by him; tho' such of them as are mark'd with an Asterisk, came abroad without having his Name prefixt to them.*

SEraphic Love, five or six times Printed, but first Publish'd in the Year 1660. 8°.

Considerations about the Style of the Scripture, whereof the First Edition was Published L

liſh'd in the year 1661. in Engliſh, and afterward turn'd into, and ſeveral times Printed in Latin, 8°.

* Occaſional Reflections on ſeveral Subjects, with a Preliminary Diſcourſe of the way of meditating there Exemplify'd; Firſt Publiſh'd in the year 1665, and afterwards turn'd into Latin, but not yet Printed in that Language, 8°.

* ☞ Of the Excellency of the Study of Theology, compar'd with that of Natural Philoſophy. Printed in the year 1674. 8°.

* Conſiderations about the Reconcileableneſs of Reaſon and Religion. To which is annex'd a Diſcourſe about the Poſſibility of the Reſurrection. Printed in the year 1675, 8°.

* A Treatiſe of Things above Reaſon. To which are annex'd ſome Advices about Things that are ſaid to tranſcend Reaſon. Printed in the year 1681, in Engliſh, and afterwards Tranſlated into Latin, but not yet Printed in that Language, 8°.

L* ☞ Of the Veneration that Man's Intellect owes to God. Printed in the year 1685.

* ☞ The Martyrdom of *Theodora*, and of *Didymus*. *London*, 1687.

☞ The Chriſtian Virtuoſo: Shewing, That by being addicted to Experimental Philoſophy, a Man is rather aſſiſted, than Indiſpoſed, to be a good Chriſtian. The Firſt Part; To which are ſubjoyn'd, 1. A Diſcourſe about the Diſtinction, that repreſents ſome Things as above Reaſon, but not contrary to Reaſon. 2. The firſt Chapters of a Diſcourſe, Entituled, Greatneſs of Mind promoted by Chriſtianity. 8°. *London*, 1690.

The End.